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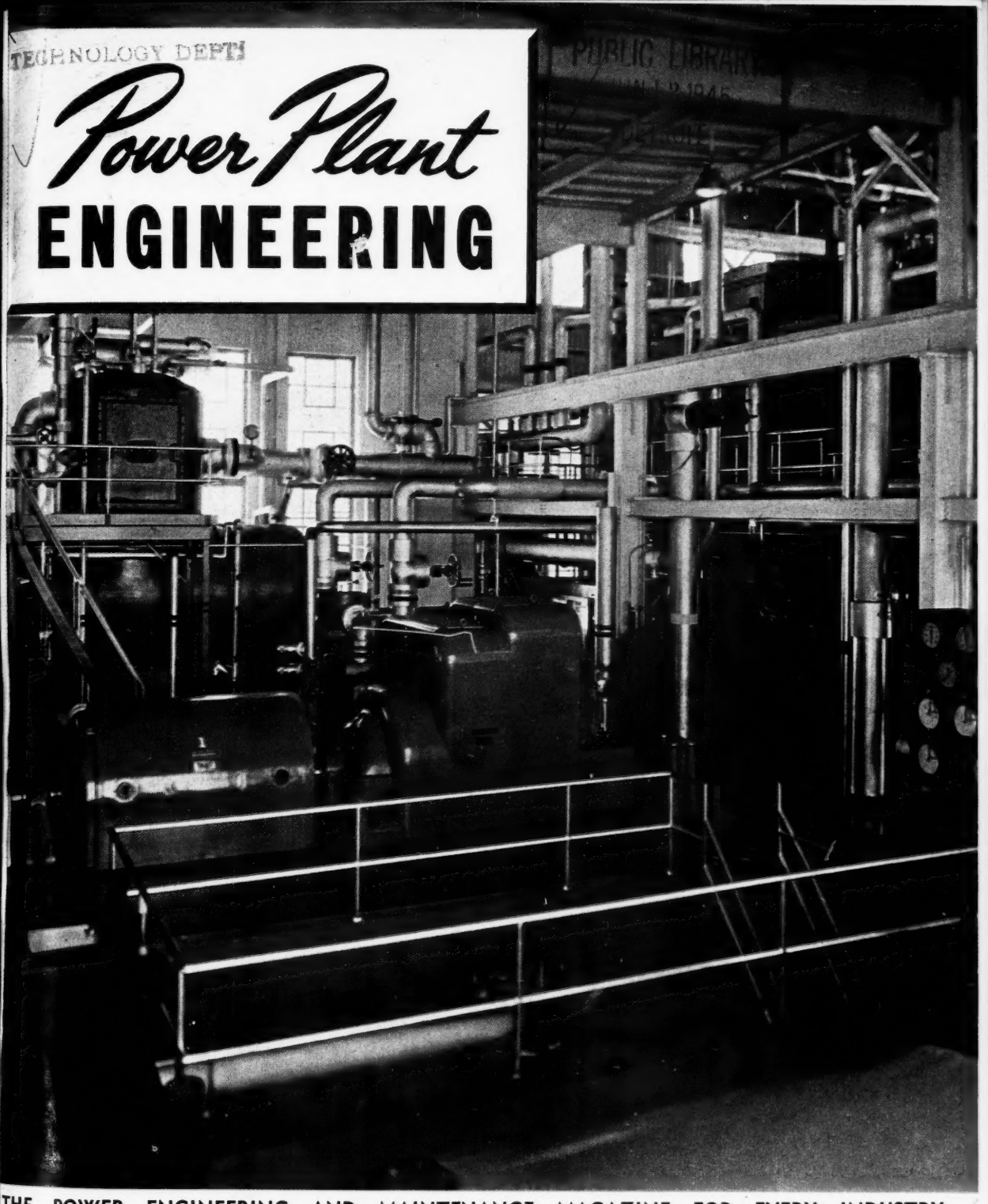
Power Plant ENGINEERING

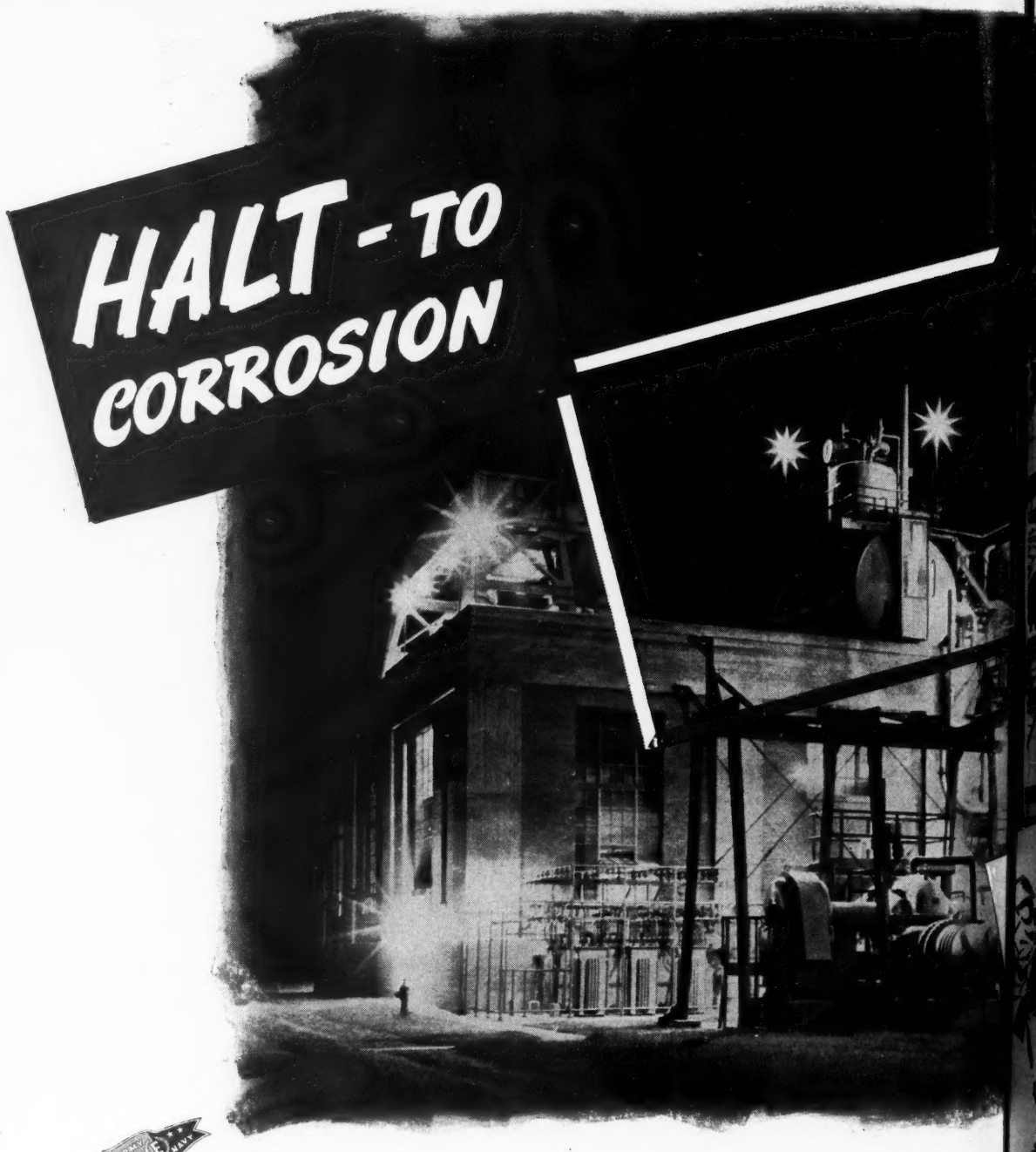


THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

JUNE • 1945

Features

POWER FOR U. S. NAVAL AIR STATION AT QUONSET POINT • NEW ARMATURE WINDING DIAGRAM • CENTRIFUGAL PUMP CONTROL • LOW TEMPERATURE WELDING • COMBUSTION CALCULATIONS • HARBOR STEAM PLANT • CONTENTS PAGE 5



STEAM TURBINES • GENERATORS • MOTORS • CONDENSERS
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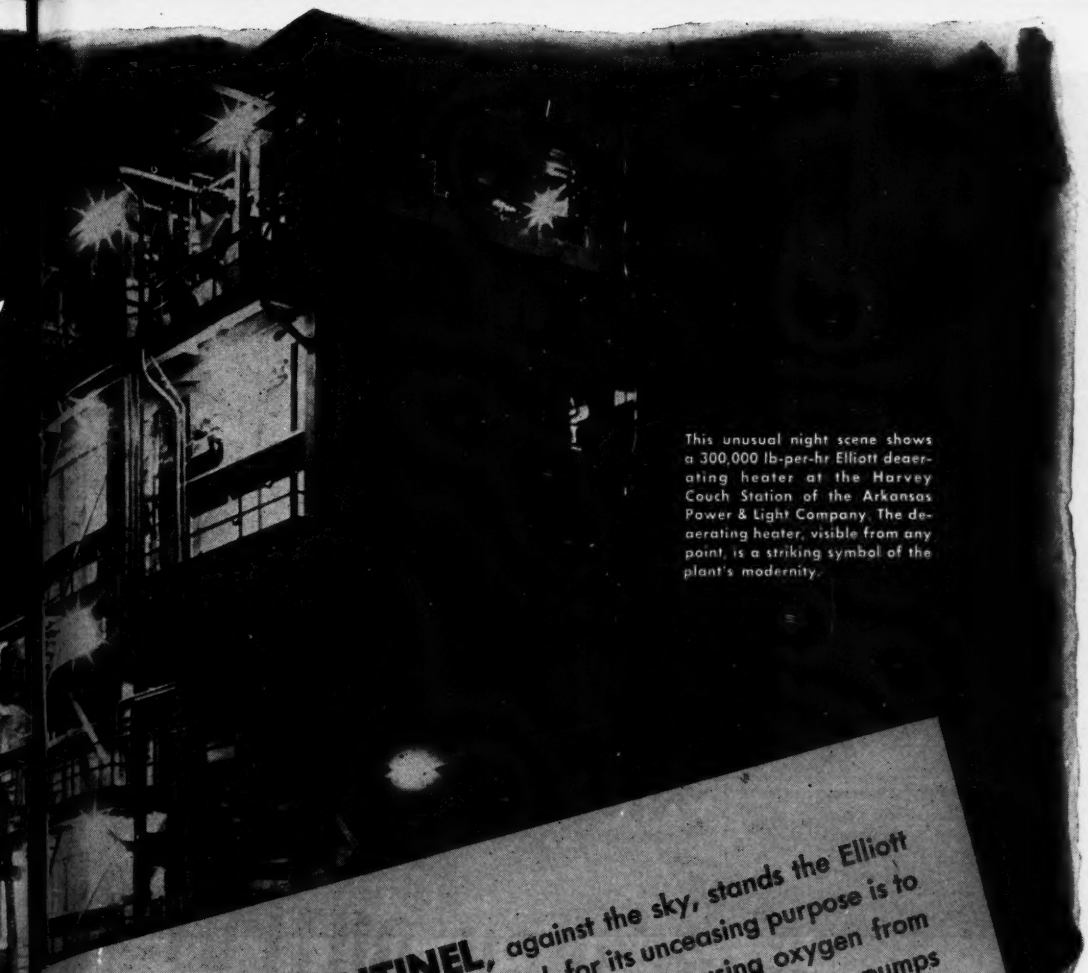
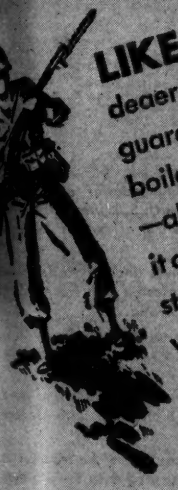


This unusual night scene shows a 300,000 lb-per-hr Elliott deaerating heater at the Harvey Couch Station of the Arkansas Power & Light Company. The deaerating heater, visible from any point, is a striking symbol of the plant's modernity.



LIKE A SENTINEL, against the sky, stands the Elliott deaerating heater. It is a sentinel, for its unceasing purpose is to guard the plant by removal of corrosion-causing oxygen from boiler feedwater. It protects boiler tubes, piping, valves, pumps —all water-handling equipment. And while giving this protection, it also provides feedwater heated to the temperature of saturated steam. Night and day this process goes on, quietly, automatically, with no fuss or trouble.

Thousands of plants large and small have used deaeration since Elliott engineers pioneered its development some years ago. This pioneering is still going on—in more and more efficient and economical applications, in the closer fitting of Elliott deaerating heaters to specific conditions. You will find it interesting to discuss your deaeration problem with Elliott engineers.

N-983

WATER HEATERS

For boiler plant security and economy

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Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

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53 W. Jackson Blvd., Chicago 4, Ill.
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NEW YORK: John A. Kershaw
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WASHINGTON, D. C., NEWS OFFICE
Business News Service
10 Independence Ave.

Subscription Information—The monthly issues are sent prepaid by second class mail. Prices: United States and possessions one year $2.00 and two years $3.00. Canada one year $3.00 and two years $5.00. Other countries one year $4.00 and two years $7.00. Address correspondence about subscriptions to Circulation Manager, POWER PLANT ENGINEERING, 53 West Jackson Blvd., Chicago 4, Illinois. Changes of address should give both old and new address and reach us by 20th of month to be effective with following month's issue. The Annual Index is furnished as a part of the December issue.

Power Plant ENGINEERING

June 1945

VOLUME 49 — NUMBER 6

Cover: General view of the main turbine room at the Quonset Point, R. I., Naval Air Station showing the application of "Color Dynamics" in painting the interior.

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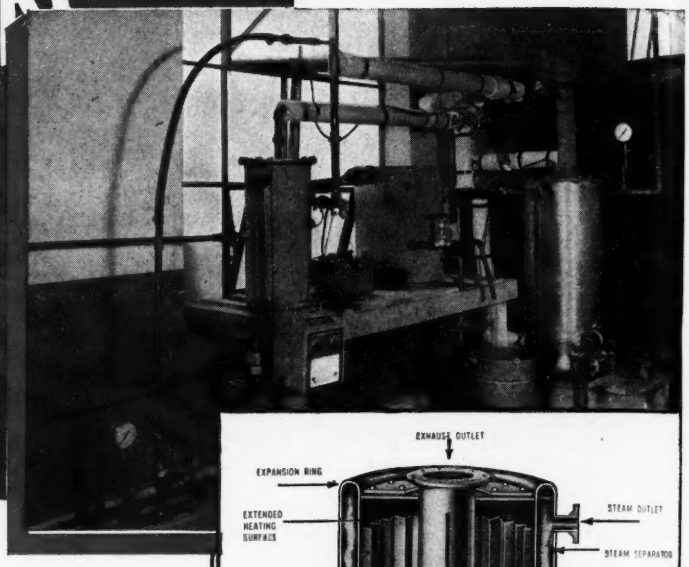
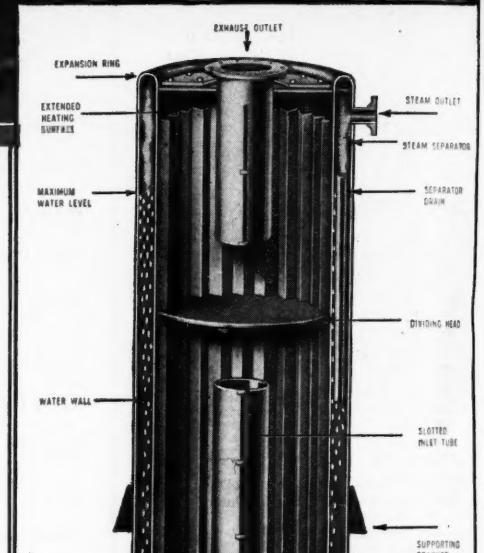
Copyright, 1945, by Technical Publishing Company.

Published monthly by the Technical Publishing Co., at 53 West Jackson Blvd., Chicago 4, Ill., U. S. A., Subscription price, $2.00 a year. Entered as second class matter September 8, 1932, at the Post Office, Chicago, Ill., under act of March 3, 1879. Vol. XLIX, No. 6.

PUT EXHAUST HEAT TO WORK

WITH MAXIM HEAT RECOVERY SILENCERS





The illustration above shows a test hook-up for Heat Recovery Silencer research in the Maxim Research Department. Here again, as in Maxim Silencers, the basis for superior performance is constant and painstaking research which results in proper basic design and a never ending search for improvement.

Maxim Heat Recovery Silencers provide effective silencing of exhaust noise, 100% spark arresting (where this is desired) and the recovery of waste exhaust heat to produce steam or hot water for heating or processing operations.

These Heat Recovery Silencers are available with automatic controls which control steaming rate by varying water level in the water wall of the Silencer. They may be run wet or dry. Highly efficient heat transfer is assured by the Maxim extended heating surface feature.

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For silencing without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.

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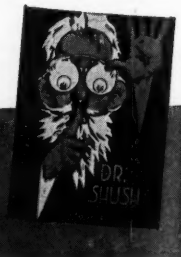

ARMY E NAVY

MAXIM

Front Lines

BEFORE AIR CONDITIONING became the important factor in war production that it is today, the opening of a copper mine was a slow procedure. Temperatures run as high as 150 F and it was formerly necessary to blow air through the tunnels for three years or more before they were cool enough to work in. Air conditioning now does the job in less than a month.—Ohmite News.

METHODS OF INSPECTION and tests for various types of scales and weights are given in comprehensive, yet compact form in National Bureau of Standard's handbook, H 37, Testing Weighing Equipment by Ralph W. Smith. Intended primarily for weights and measure officials, the data should prove valuable to engineers charged with maintaining the weighing equipment of commercial and industrial plants.

TEXAS GAS for the Pittsburgh area is brought in by a 24-in. pipe line, 1180 miles long. This line runs from a dehydration plant just west of Corpus Christi, Texas, to Cornwell Station, W. Va., from which the 20-in. extensions tie it into existing gas distribution systems. The construction of the project and the details of the compressor station are fully described by Elton Sterrett in the April Compressed Air magazine.

CARTELS Threaten Economic Progress, said J. Howard Pew, in a recent address before the National Conference of Business Paper Editors and presented many facts and cogent arguments to prove his point. A great many people, including this writer, agree with Mr. Pew that the influence of cartels has been definitely harmful on the whole. But the unfortunate fact is that they are still extremely strong and numerous and there is considerable evidence that they are increasing in number and power. They will have to be fought, says Mr. Pew, and he suggests a number of ways in which this might be done. Those interested in these ideas should obtain a copy of his complete address from the Sun Oil Co., 1608 Walnut Street, Philadelphia 3, Pa.

A DARNING NEEDLE for mending the broken noses of bombers is one of the interesting developments of aircraft production during this war. Domes and surfaces of bombing planes are often made of Plexiglas. When cracks or other flaws develop in these, a small Nichrome wire is inserted in the crack, both ends are connected to electrodes, a low voltage current is then turned on and the wire drawn along the crack. The plexiglas welds immediately behind the wire. At the crack's end, one electrode is disconnected and the wire drawn out.

COVERED WOODEN HIGHWAY BRIDGES as a hobby—well, that certainly is an original one. The hobbyist is Jay Jacobs, past president of the New Jersey Society of Professional Engineers. He was first intrigued by the scenic value of old covered wooden bridges and although there is very little detailed engineering information on them, he has collected practically all there is. He has made a scale model of the covered bridge over Jordon Creek in Lehigh County, Pa. There are a number of fine examples of the covered wooden highway bridge still in existence, usually preserved for historical and scenic reasons and even for utility purposes. In view of the fact that he is unearthing information about the engineers and constructors who designed and built these old bridges and that they had to wait 100 years or more for their handiwork to be recognized, Mr. Jacob asks how many of us today can identify the engineer-designer of such bridges as the George Washington, the Pulaski, or the Golden Gate bridges?

EXPENDITURE of $790,000,000 by the nation's electric companies and their new customers in extending rural electrification in three years was announced recently by C. W. Kellogg, president of EEI. It is expected that about 1,000,000 new rural customers, 600,000 of them farms and 400,000 rural non-farm homes will receive service from the electric companies within the three-year period. The electric companies will spend $290,000,000 to build the required lines, and the new customers about $500 each for wiring and equipment.

BI-METAL, BI-WALL TUBING developed for service in aircraft engines may have wide applications in food, chemical and refrigeration industries. It is fabricated of monel strip plated on both sides with a thin layer of copper and then rolled into a double-walled cylinder with the copper between the two walls. Heat treatment causes the copper to fuse into a permanent bond with the monel. This cannot be separated up to about 2400 F and the tubing is designed for pressures ranging from 65,000 psi to 95,000 psi. This bi-metal tubing has also been used for evaporator tubes designed to be self-descaling and consisting of an admiralty brass tube with a strip of monel silver-brazed along one side. The difference in expansion of the two metals under variations in operating temperatures breaks off deposits on the tubes.

CRUSH DRESSING is the process of using hardened steel rolls to form or dress grinding wheels to a wide variety of shapes which in turn can be transferred to the work part. The process is described and illustrated in detail in Grits & Grinds, No. 2, Vol. 36.

YES, YES—we know, we know. It's "craft," not "crafts." (Front Lines, May, page 7, col. 1, Par, 3, line 12.)

"SOME AREAS in the world have large known natural resources but a low standard of living, whereas some countries with meagre resources of this nature enjoy a standard of living that is relatively good. Among those in 'have' category are Russia, Venezuela, Colombia, Spain, Mexico. In the second category would be included the British Isles, France, Switzerland, Germany, and Czechoslovakia. Skill (also a natural resource), the will to work, cheap internal transport, abundant food and power, favorable climatic conditions, and maritime location all play a part. The United States, providentially, is the only country possessing all the foregoing in combination."—Lucius W. Mayer, consulting engineer, writing on Mineral Economics in the February issue of Mining and Metallurgy.

RECENTLY we sent out to a large number of readers a questionnaire asking, with what we fondly considered was considerable tact, a number of questions about how they read Power Plant Engineering. This is only one of the methods we use to determine how they do it, obviously a matter of the most vital importance to us. One of the questions: "Do you read Power Plant Engineering regularly?" On one questionnaire returned, we got this answer: "I paid for the magazine and I don't know that it is any business of yours if I read it or not."

AS IN EVERY OTHER department of American life, you will get as many opinions about post-war aviation activity as there are people talking to you about it. For example, W. A. Patterson, president of United Air Lines, holds that although air traffic will increase fivefold after the war, it will not be a mass transportation business and there will be no immediate technical miracles in it. We'd rather have the opinion of somebody like Mr. Patterson, who cannot afford to be wrong by more than a few per cent, than the wishful thinking of most of the people who talk about it.

BILLY B. VAN, the stage, screen and radio comedian, is now a member of the Human Relations Division of The Fellows Gear Shaper Co., Springfield, Vt. He believes in putting showmanship into human relations in industry and tells in detail how he does it in a recent issue of the Executives' Service Bulletin.

SHIPBUILDING in 1944 was again the nation's leading single consumer of steel but not by so large a margin as in 1943, says Steel Facts. Builders of merchant and naval vessels were supplied by the steel mills last year with 10,287,000 tons of steel, or 17 per cent of the total of 60,353,000 tons of products shipped during the year. In 1943, they received 11,509,000 tons—19 per cent of the total of 59,906,000 tons of products shipped.

HAVE YOU WONDERED why it is that the Russians have been able to open up so many Arctic ports and conduct so much shipping activity in waters normally filled with heavy ice? Also have you wondered about the ice breakers used on our own Great Lakes with so much success during the past winter and why it was not possible to do the same things before? The answer is a new design of ice breaking ship with a propeller in the bow of the vessel. This bow propeller can be driven in either direction. In one direction it builds up a bow wave to help break the heavy ice, in the other direction it draws water out from under the ice causing it to break of its own weight.

FOUR TYPES of heat recovery systems used successfully by sulfate or soda pulp mills for condensing digester blowdown steam and transferring the heat to wash water are described in detail in Heat Engineering, No. 7, Vol. 19. The four systems are direct contact system, surface condenser system, liquid to liquid system and vapor to liquid system.

THE $2500 ACHIEVEMENT AWARD of the American Association of University Women, granted annually to an outstanding woman scholar in recognition of distinguished achievement, goes this year to Dr. Katharine B. Blodgett, researcher in molecular films at the General Electric Research Laboratory at Schenectady. Dr. Blodgett's invention of "invisible glass" has received widespread public recognition, says the New York Times, but to the world of science that is only a by-product of her important long-time research on methods of making films of almost infinitesimal thickness.

THERE IS MUCH TALK of post war planning for adequate production and full employment in order to maintain the American way of life. Instead of windy talk, the community of greater Vineland in New Jersey, has actually done something about it. In an area of 76 square miles, a well-planned system of dairy, fruit and vegetable farms, glass factories, clothing industries, and the like, function effectively. And the Borough owns and operates its own municipal light plant, with a total rated capacity of 11,000 kw. The balance between agriculture, industry and an attractive physical setting attained at Vineland is worth some study.

DICHLORO-DIPHENYL-TRICHLOROETHANE — D.D.T. for short, has been released in limited quantities for civilian research agencies. This famous powder with the frightening name is the powerful insecticide that won the battle over body lice for the Army in North Africa, conquered a typhus outbreak in Naples and kicked the malarial mosquitoes out of Saipan. About 100,000 lb have been released by WPB to civilian research agencies. A great deal is still to be learned about this substance, such as its effect on beneficent insects like bees.

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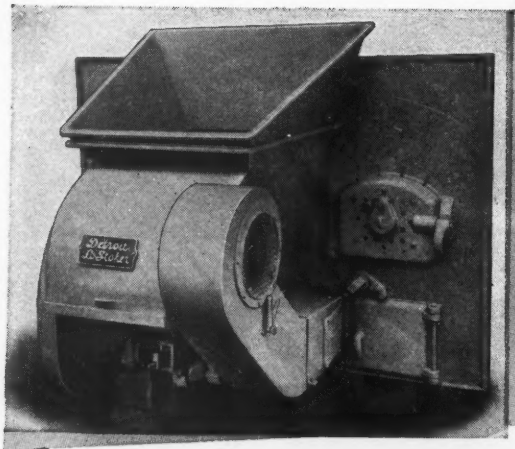
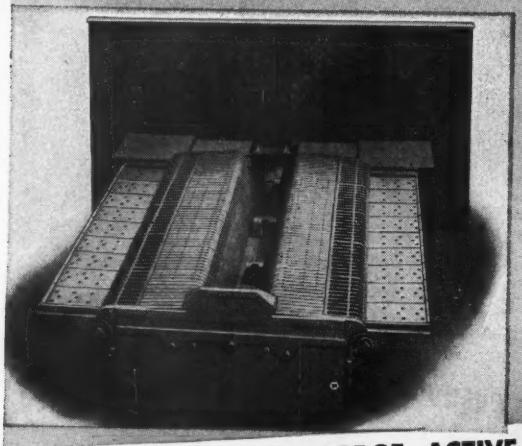


DETROIT LOSTOKER (BRICK-SET TYPE)



LOSTOKER HAS LARGE ACTIVE GRATE AREA TO FIT THE FURNACE

If IT'S A SIDE CLEANING UNDERFEED STOKER

DETROIT LOSTOKER

For approximately 50 to 150 horsepower boilers provides adjustments for coal feed and distribution. Brick-set application for tubular or water tube boilers, built to fit the furnace. When applied to high firebox boilers, no front or side wall brickwork is required. Automatically controlled—a great fuel saver.

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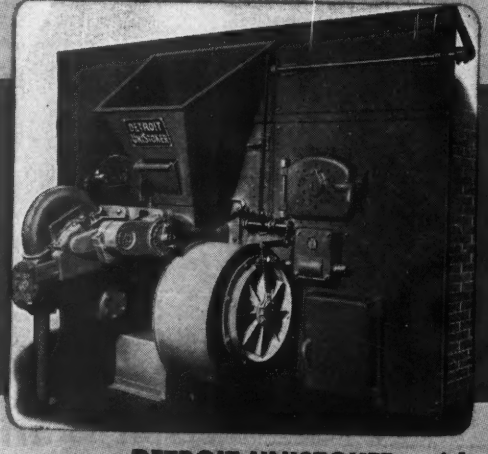
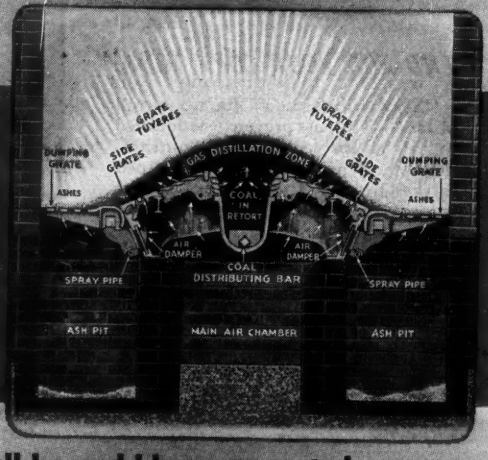


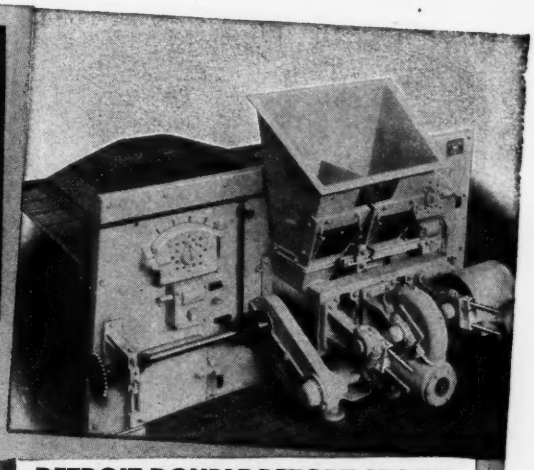


DETROIT UNISTOKER—with full housed blower mounted at stoker front is a compact, efficient unit type

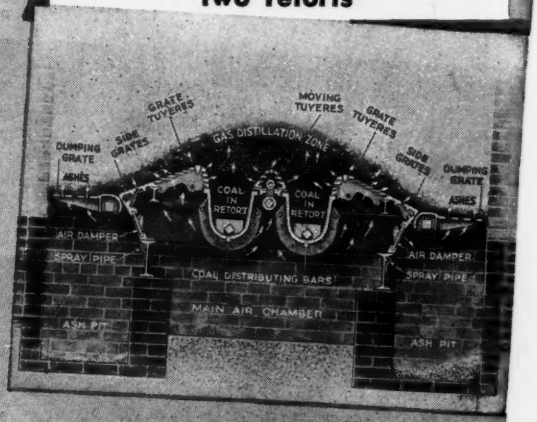
DETROIT STOKER COMPANY

We have it!

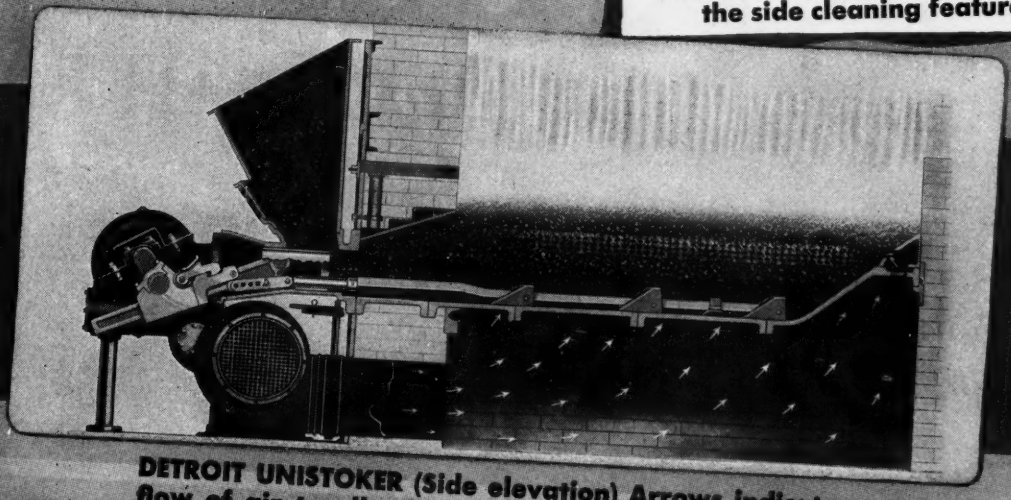
MANY SIZES AND CAPACITIES FOR ALL BOILERS . . .



DETROIT DOUBLE RETORT STOKER —is a multiple Retort stoker of two retorts



DOUBLE RETORT is readily adapted to existing boilers because of the side cleaning feature



DETROIT UNISTOKER (Side elevation) Arrows indicate flow of air to all parts of the large active fuel bed

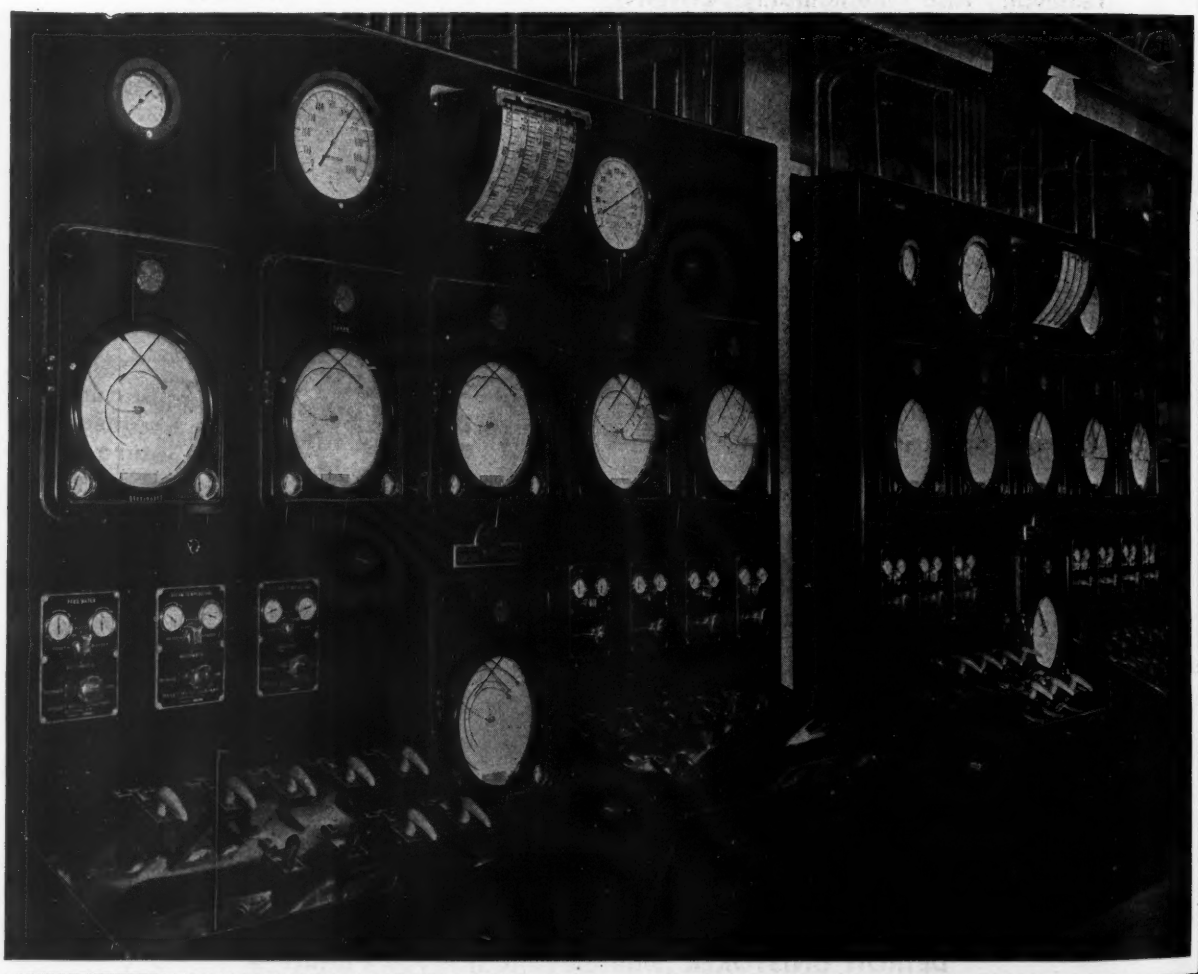
GENERAL MOTORS BUILDING • DETROIT 2, MICHIGAN

Works at Monroe, Michigan • District Offices in Principal Cities • Built in Canada at London, Ontario

MORE THAN

AND

Bailey Boiler Control Panels for two 135,000 lb. per hour capacity, oil and gas-fired boilers in a Western Power Station



BAILEY METER CONTROL

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEA

N METERS

D CONTROLLERS

A Bailey Boiler Control System is more than just a group of meters and controllers recording and controlling certain factors in the boiler plant. It is a means of improving plant operation from the standpoints of:—

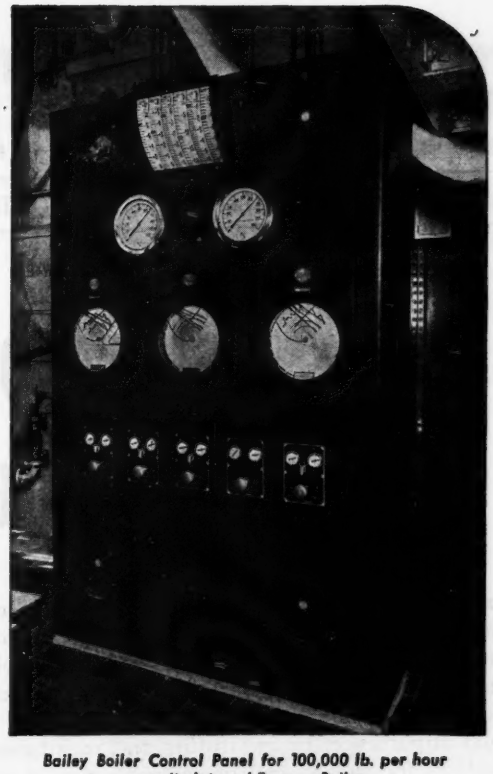
1. Continuity of service **3. Steaming capacity** **5. Safety**
2. Fuel conservation **4. Conservation of manpower**

Bailey Control Systems are effective because each system is carefully engineered to the requirements of the unit which it serves. The experience gained from thousands of successful combustion control installations serves as a basis for this engineering service which starts with the selection of equipment and continues through the design, construction, calibration, installation and final adjustment on the job.

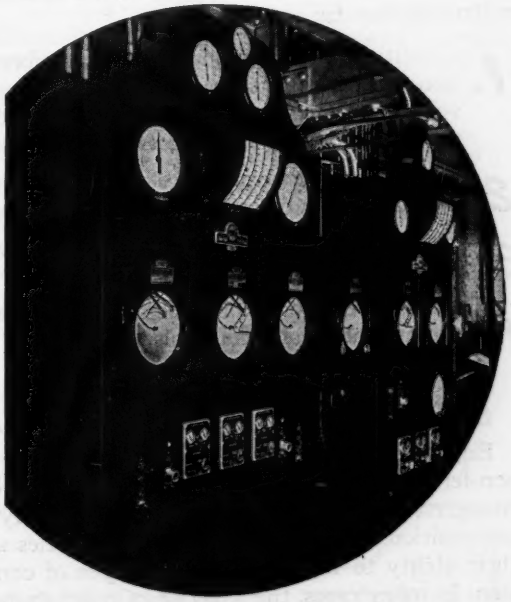
Engineering work is done in the user's plant by Bailey Field Engineers who have been thoroughly trained in combustion and automatic control practice. These engineers are stationed in over 30 industrial areas throughout the United States and Canada for the purpose of rendering prompt "on the spot" engineering service without undue traveling expense.

The Bailey engineer in your community has a wide background of combustion engineering know-how at his command. It includes the records of tests on thousands of boiler installations covering a wide range of fuels, furnaces and fuel-burning equipment. He has more to offer than meters and controllers. He is primarily interested in helping you to secure optimum operating conditions in your plant.

G-19



Bailey Boiler Control Panel for 100,000 lb. per hour capacity Integral-Furnace Boiler



Bailey Boiler Control System in an Eastern Paper Mill

BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND 10, OHIO
Bailey Meter Company Limited, Montreal, Canada

The Complete Combustion Control System

NTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

Scovill Tube News

Vol. 3 SCOVILL MANUFACTURING COMPANY, Waterbury 91, Conn. No. 2

Selection and Care of Condenser Tubes

Operating engineers are vitally interested in obtaining long trouble-free service life from condenser and heat exchanger tubes; maximum service can be expected only by selecting a suitable tube material for the particular application and, of equal importance, by instituting and maintaining practices for the control of certain types of corrosion.

The choice of an economical tube material requires careful consideration, and a decision should be based on the results of a study of the following controlling factors:

1. Conditions of service, including such information as operating temperature and pressure, velocity of media contacting tubes, composition of solutions, gases, vapors, being handled.
2. Previous service experience with tubes in a particular unit or similarly operated units.
3. Type or form of corrosion which predominates.
4. The inherent corrosion-resistant properties of the available tube materials.

SELECTION OF TUBE MATERIAL

Engineers have a choice of a large number of non-ferrous alloys for condenser and heat exchanger tubes. These alloys vary considerably in composition, chemical and physical properties and their ability to withstand certain types of corrosion. In many cases, the selection of a satisfactory tube material is not a difficult matter. As an example, under conditions where dezincification of condenser tubes is the major problem, the use of a dezincification-resistant tube alloy — Phosphorized Admiralty metal — is indicated; under a somewhat more limited set of conditions, Red Brass, Arsenical Copper or Deoxidized Copper may also be used to overcome tube deterioration of the dezincification type.

In another case, condenser tubes may be required to withstand the action of a high velocity circulating water or other conditions of service which would result in the rapid erosion of tube walls and, combined with corrosion, shorten the life of some tube materials to a marked degree. Conditions of this kind require the choice of tubes of erosion-resistant alloys, such as Aluminum Brass or 70–30 Copper-Nickel.

Very often, the operating conditions under which tubes must serve offer a more complex corrosion problem than the cited examples and such cases are only solved satisfactorily by close attention to all contributing factors to corrosion.

ATTENTION TO CONTRIBUTORY FACTORS

Many condenser tube corrosion problems can best be controlled by eliminating or correcting the factors contributing to corrosion. This is especially true in installations where certain types of corrosion are active. In cases of tube failures which can be attributed to "deposit attack", freedom from such attack cannot be assured by a change in tube alloy. "Deposit attack" of tube surfaces is initiated by foreign materials which are carried into the tubes by the circulating medium and become lodged on the tube walls; such materials as coal or coke, clinkers, stones, wood, paper, shells or other marine growths may contribute to this form of corrosion under certain conditions of service. Intense local pitting and downstream erosion-corrosion, characteristic of attack at and adjacent to foreign deposits, can be prevented or minimized by two expedients — adequate screening of the circulating water and a periodic thorough careful cleaning of the tubes.

Another source of tube failure has its origin in the formation of electro-chemical cells at local areas of the tube walls; this form of corrosion is called "concentration cell action." Corrosion of this type is often formed at recessed areas which may exist between tubes and tube sheets, baffles, and support plates, or at any location where cracks, crevices or other areas are found into which liquids may seep and become trapped.

Concentration cell action may also be experienced beneath porous layers of scale or corrosion product over the metal surface or at discontinuities in protective films or coatings. The remedy for overcoming corrosion of this kind again lies in certain definite precautionary or corrective measures rather than in a change in tube alloy. Briefly, all recesses, crevices, etc. at tube surfaces between tubes and tube sheets, baffles, etc. should be avoided; screening of the circulating media and cleaning of the tubes are beneficial as in the case of deposit attack; lastly, effective chemical treatment of media contacting the tubes has been helpful in many cases.

CHANGE IN OPERATING CONDITIONS

Certain unexpected corrosion problems often develop during the service life of tubes. It is not unusual to find that operating conditions change in some respect and such changes are then reflected in a different type of tube attack to that normally experienced. Thus, tube installations which have been trouble-free, may suddenly show evidence of serious corrosion.

Periodic inspection of tubes and prompt action in diagnosing the possible sources of trouble under such circumstances will often lead to remedial measures which can be applied to arrest an otherwise corrosive action on the tubes.

In some instances, as an illustration, the tubes in a unit will suddenly show definite evidence of inlet end attack although no trouble of this kind had previously been experienced. At the first indication of this trouble, a study can be made to determine what particular conditions of service are causing it, and this study can be followed by definite recommendations for alleviating the attack. If such recommendations cannot be carried out for any reason and the attack continues, a suitable coating of paint or cement can be applied to the inlet ends periodically to stop the action. More permanent relief in severe cases can be obtained by the use of properly designed metal or plastic inserts to cover affected tube areas.

THREE SCOVILL SERVICES

The foregoing information on the selection, use and care of condenser and heat exchanger tubes has been necessarily brief. The subject is covered in more detail in the Scovill Condenser Tube booklet, a copy of which will be sent upon request to Scovill Manufacturing Company, 17 Mill Street, Waterbury 91, Connecticut.

Information like this, regularly provided through "Scovill Tube News" and printed literature, is part of *Service in Manuals* — one of three Scovill services.

The other two are *Service in Men* which brings you, through Scovill engineers, specialized consultation on tube problems and installation methods . . . and *Service in Metals* which covers the selection of alloys and study of specific problems in the field and in the laboratory.

ARMY E NAVY

THIS IS NUMBER FIFTEEN in a Series of Scovill Advertisements to help you get longer life from condenser and heat exchanger tubes.

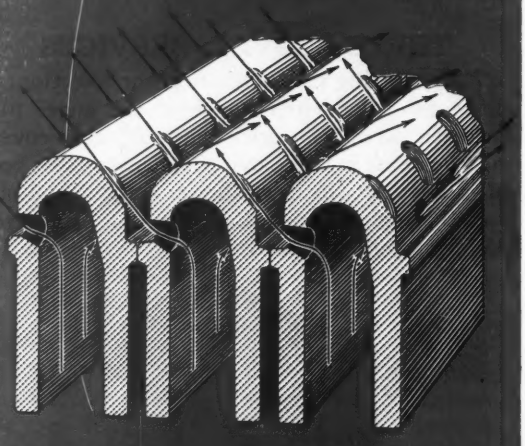
Scovill
MANUFACTURING COMPANY
WATERBURY 91, CONN.

SCOVILL CONDENSER TUBES

ONE PRODUCT... THREE SERVICES

Service in Manuals... Service in Metals... Service in Men

"CROSS FIRING"
GIVES BETTER AIR DISTRIBUTION



The dumping grate bars of the Æ Perfect Spread Stoker are uniquely designed with "staggered" non-clogging ports to provide a steady cross flow of air that uniformly blankets the entire grate area. This assures a rapid and complete mixture of fuel and air, and a uniform burning rate at all times. In addition, the bars are thoroughly air-swept from below for proper cooling.

END BOILER ROOM DRUDGERY

DIRTY, tiresome jobs with hand stoking that make boiler room operations wasteful and distasteful are virtually ended when you install an Æ Perfect Spread Stoker. You'll marvel at the elimination of these inefficiencies and the way steam and operating costs drop.

Fully automatic and simple in operation, this modern, streamlined stoker requires practically no attention. It runs steadily, quietly—regardless of the steam demands—without clogging or jamming. It keeps the boiler room neat and clean and makes grate cleaning and ash removal surprisingly easy.

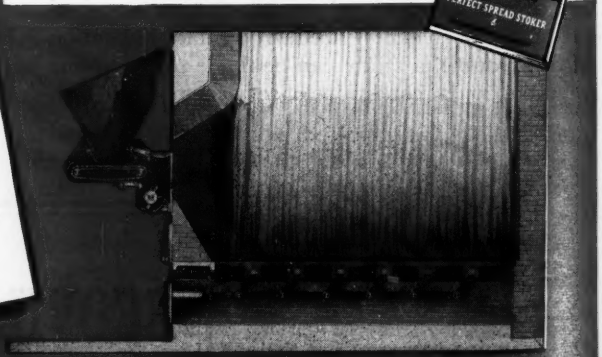
When you consider all these advantages, as well as its ability to burn economically the widest range of solid fuels, you'll see how the Æ Perfect Spread Stoker keeps labor requirements low and makes waste go. You can get all the facts by writing today for the eye-opening Æ bulletin on low cost steam production.

If Your Steam Requirements Call for 175 H. P. up to 200,000 lbs. per hour—

YOU NEED THIS BULLETIN

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

Æ PERFECT SPREAD STOKER



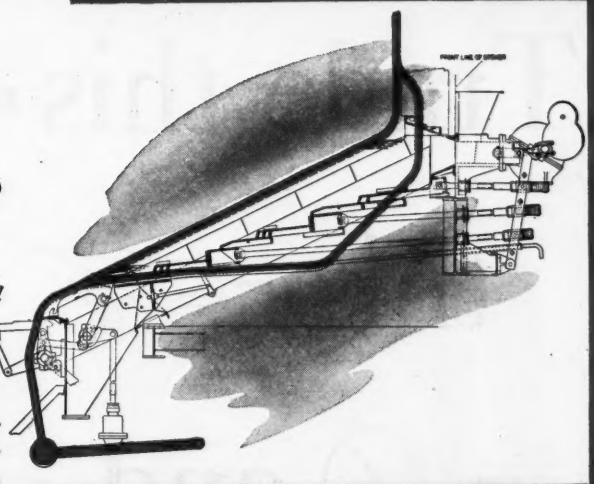
Other Æ Products: Æ-Taylor Stokers, Lo-Bed Boilers, Marine Boiler Accessories, Non-Clog Fuel Feeds, Overfeed Fuel Stokers

AMERICAN ENGINEERING COMPANY

Subsidiaries: COCHRANE CORPORATION, Philadelphia, FARADAY ELECTRIC CORPORATION, Adrian, Mich.

PHILADELPHIA 25, PENNSYLVANIA

WILL THIS STOKER AFFECT YOUR FUTURE OPERATIONS?



PERHAPS you've heard about the *improved* Taylor Stoker—a time-tested stoker with outstanding *new* features that you should not overlook when selecting fuel firing equipment for your future power plant operations.

Precision control feed mechanism and provisions for better air flow mean more thorough combustion and minimum stack discharge. The stoker has simplified unit construction throughout with fewer moving, longer wearing parts. Continuous ash discharge and numerous other advantages are additional aids to efficient operation and low cost steam generation.

Examine *all* these features in the Type "R" Taylor Stoker booklet before you make *any* decision. A few minutes invested this way will pay dividends in worthwhile information. Mail your request to us *today.*

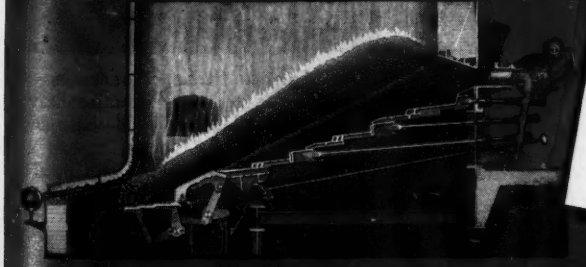
TYPE "R" WATER-COOLED TAYLOR STOKER has Important Operating and Maintenance Advantages

The Taylor Stoker is available with integral water tubes connected into the boiler circulation. This feature assures maximum fuel flexibility, higher operating efficiency and low boiler outage.

IF YOUR Steam Requirements Call for 20,000 to 500,000 lbs. per hour—

YOU NEED THIS BOOKLET

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

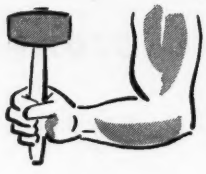
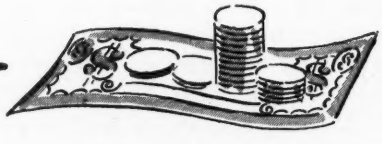


Æ TAYLOR STOKERS
AIR-COOLED & WATER-COOLED

AMERICAN ENGINEERING COMPANY

Subsidiaries: COCHRANE CORPORATION, Philadelphia, FARADAY ELECTRIC CORPORATION, Adrian, Mich.

PHILADELPHIA 25, PENNSYLVANIA

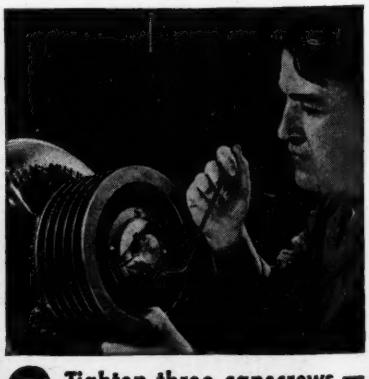
Trade this  for this ; save and 

No more *forcing* of sheaves. Simple wrench operates Allis-Chalmers' "Magic-Grip" — ***fastest mounting and demounting sheave on the market.*** Saves time, money.

SEE HOW QUICKLY, EASILY THIS NEW SHEAVE MOUNTS AND DEMOUNTS

1 Place sheave on shaft. Slides on smoothly because clearance is provided by expanded bushing. There's *no* hammering — *no* forcing! Complete sheave and bushing unit comes intact—ready for quick, easy mounting.

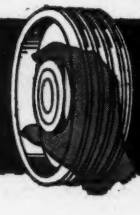
2 Slide to desired position. Sliding easily, sheave can be placed *exactly* according to straight-edge . . . giving you true alignment with resulting smooth performance. A minimum of time is required.



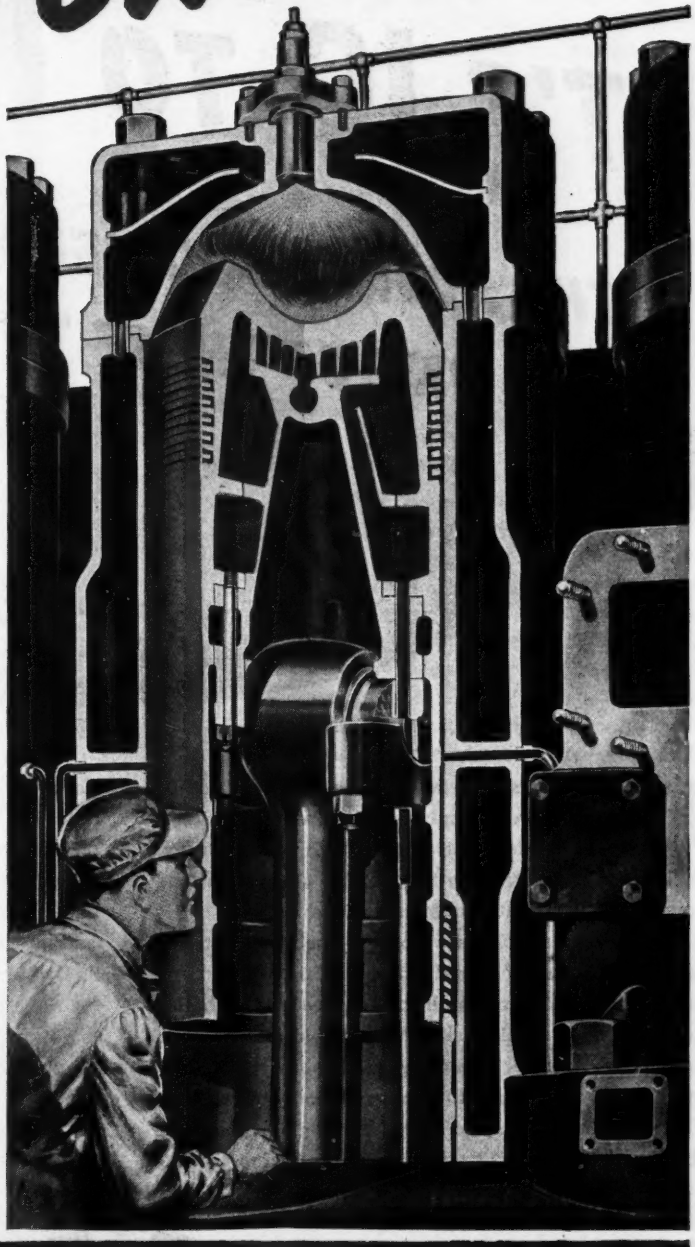
3 Tighten three capscrews — and it's ready to go! Entire sheave is locked securely to shaft and *grips like magic!* No set screws to damage shaft. Send for Bulletin B6310. Allis-Chalmers, Milwaukee 1, Wis.

A 1855

Allis-Chalmers Texrope

"MAGIC-GRIP"  SHEAVES

ONE WAY TO GET FULL POWER!



Make Certain Your Diesel Lubricating Oil Will Keep Rings Free, Prevent "Blow-by"!

HERE, in the ring zone of your Diesel engine, combustion makes things plenty hot. Unless your lubricating oil can take this heat, it will "cook," form hard deposits that cause ring sticking.

Loss of valuable power due to "blow-by" is the inevitable result.

Gargoyle D. T. E. Oils Nos. 1 to 5 are specially designed to withstand the terrific heat in Diesel ring zones . . . to keep rings free.

These famous oils reduce deposits to an absolute minimum, and those that do form, are soft and flaky.

Just as important, these Gargoyle D.T.E. Oils provide strong films that resist rupture and reduce wear on pistons, cylinders and rings.

You get full power — and your Diesel stays on the job longer with less "down-time" for repairs and replacements.

SOCONY-VACUUM OIL CO., INC.

Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Co. • General Petroleum Corporation of California.

GET CORRECT LUBRICATION FOR YOUR ENTIRE PLANT WITH SOCONY-VACUUM ENGINEERING

GARGOYLE Lubricants

Socony-Vacuum's FIVE STEPS to Lower Production Costs for You

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

HERE are three stoker designs — each developed to meet a different combination of requirements — which have demonstrated through actual survey, their complete suitability for 90% of all installations covered by C-E contracts of recent years.

These three simplify for you the problem of stoker selection to one of merely determining which type is the answer to your conditions of steam load, boiler design, and available fuels. With that done, you can be sure of reliable performance, durability, and low maintenance by entrusting your requirements to C-E. For embodied in each of these three designs are all the "know how" and experience gained from the installation of over 18,000 stokers of every type, above residence size, to serve approximately 5,000,000 rated boiler horse power.

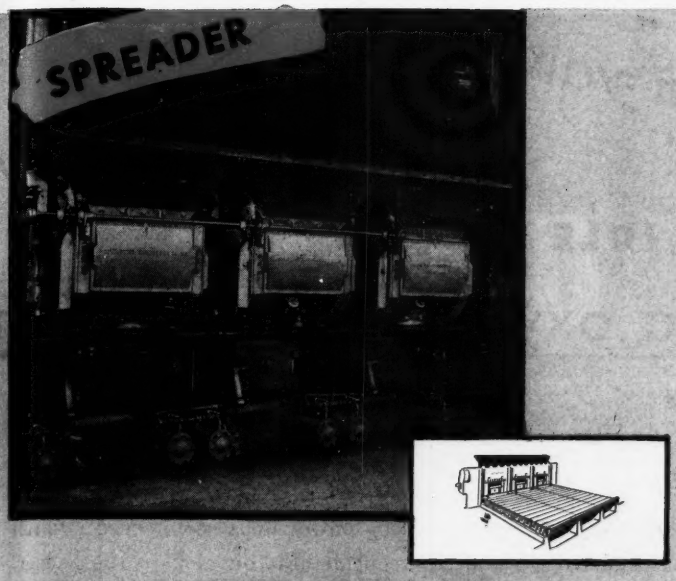
Comprehensive as these three types are, the C-E line includes other designs which round out the most complete line of stokers offered by anybody anywhere. So if your installation falls outside the 90% and within the remaining 10%, you will certainly find the answer to your needs among modern C-E designs of Multiple Retort, Travelling Grate, and Chain Grate Stokers.

Now is none too soon to plan for your new post-war installation or needed replacements. A C-E engineer will be glad to discuss your problem with you. A-829

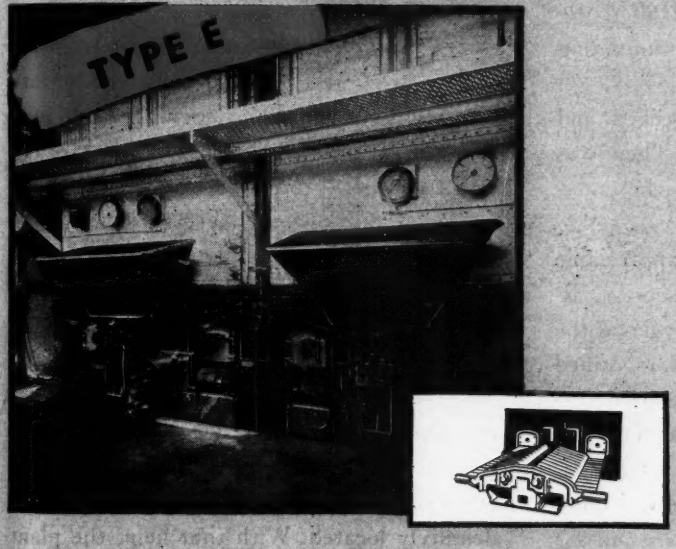
COMBUSTION ENGINEERING

200 MADISON AVENUE · NEW YORK 16, N. Y.

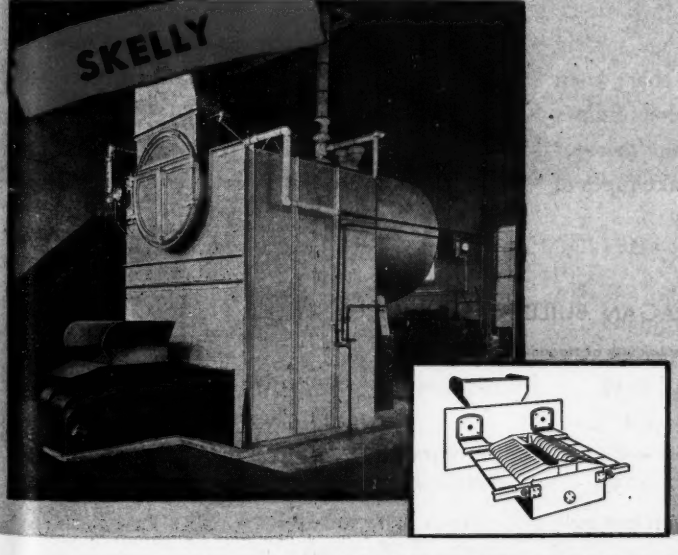
C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



Approximate Application Range — 150 boiler hp to largest units suitable for stoker firing. A simple, rugged stoker designed to burn a wider variety of fuels than any other type of mechanical firing. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. Rotating spreader blades feed coal into the furnace in crisscrossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on a grate — stationary or dumping type. Grate surface is zoned for regulating air admission and to facilitate cleaning.



Approximate Application Range — 150 to 600 boiler hp. A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals. Ram feed is supplemented by a reciprocating sliding bottom. Grate surface consists of hollow, air-cooled grate bars, alternately fixed and moving, to condition the fuel bed and assure its steady movement toward the dump trays. Air supply under zoned control with provision for introducing air over the fire. Steam or hydraulic drive.



Approximate Application Range — 20 to 200 boiler hp. A compact, self-contained unit offering all the advantages of underfeed firing. Moving grate bars assure lateral distribution of fuel and maintain a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. Integral forced-draft fan, with vortex inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.

They turned a valve

ON AN IDLE PUMP

. . . and oxygen contamination

To a Hall engineer, an increase in sodium sulphite consumption suggests oxygen contamination. Consequently when this occurred recently in a certain plant, the Hall representative started to trace the contamination to its source.

The deaerating heater was checked and found to be functioning properly. There was no leakage into the system from the emergency cold water lines.

As the checking continued, appreciable oxygen was found at the pump suction, although there was zero dissolved oxygen at the heater discharge. This definitely identified the pump as the source of contamination—but there was still the problem of how this could happen. Once the source of contamination was determined, the plant engineer knew the answer. The feed pumps in use at the plant require equalizing pipes which carry away any leakage from the last stage sealing sleeves. The engineer remembered that, when the pumps were put in, these equalizing pipes were not carried back to the pump suctions but discharged into one of the intake pipes of the feed water heater. This particular intake pipe returns power house condensate, which contains considerable oxygen, to the heater.

Since one pump was always idle, the pressure in the equalizing line of that pump was less than that on the power house condensate line, hence undeaerated condensate could leak back through the equalizing line and into the pump suction. From this point it was picked up and sent into the boilers.

The whole problem was solved by merely shutting the valve in the pump suction line to the idle pump.

This incident is an excellent example of cooperation between the Hall service engineer and the plant engineer. The Hall representative, as part of regular Hall service, checked every phase of operation until the trouble was definitely located. With that help, the plant engineer was able to use his detailed knowledge of the equipment to determine how the contamination could occur and to correct it.

Every plant that generates its own steam power can profitably use Hall Service. Write us for full information.

HALL LABORATORIES, INC. · HAGAN BUILDING · PITTSBURGH 30, PA.

A subsidiary of Hagan Corporation

HAGAN
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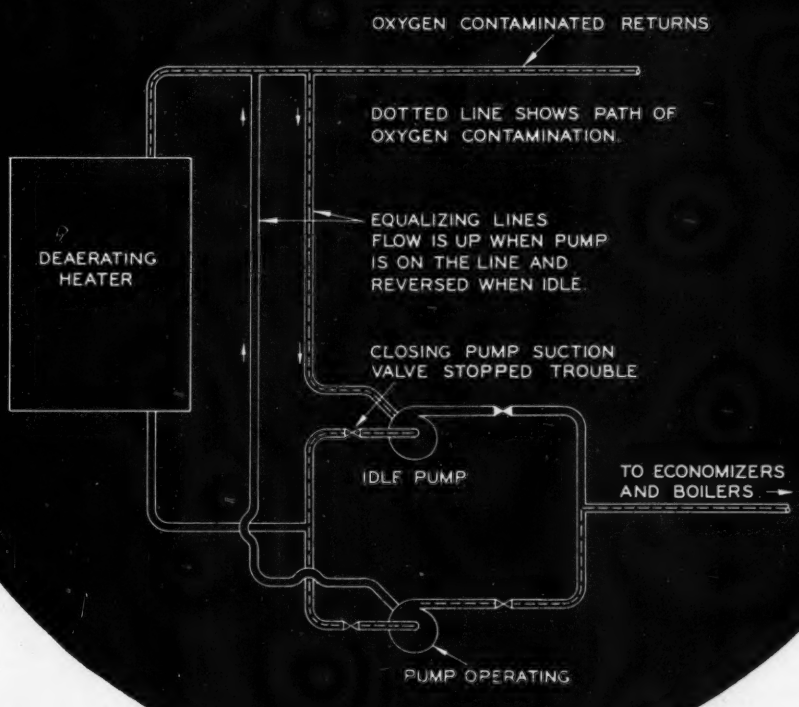
STOPPED


OXYGEN CONTAMINATED RETURNS
DOTTED LINE SHOWS PATH OF OXYGEN CONTAMINATION.
DEAERATING HEATER
EQUALIZING LINES FLOW IS UP WHEN PUMP IS ON THE LINE AND REVERSED WHEN IDLE.
CLOSING PUMP SUCTION VALVE STOPPED TROUBLE
IDLE PUMP
TO ECONOMIZERS AND BOILERS
PUMP OPERATING

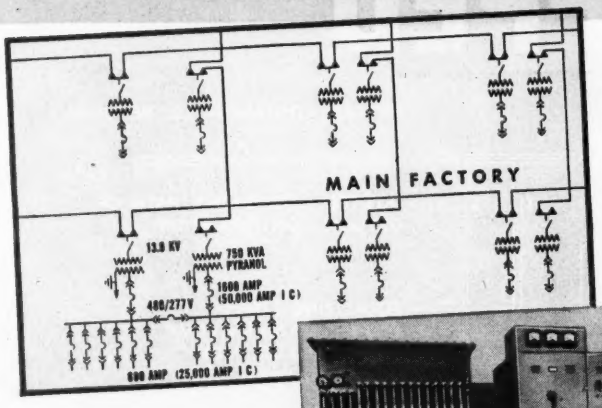
HALL SYSTEM *of Boiler Water Conditioning*

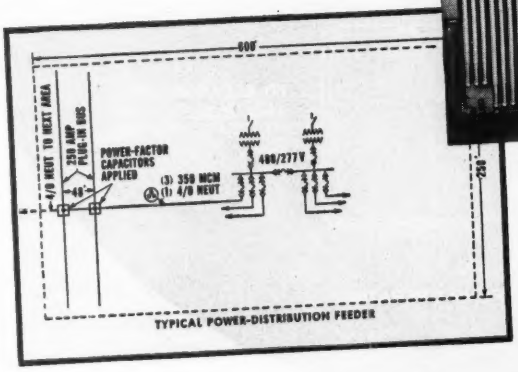
HERE'S WHAT HALL CLIENTS GET:

1. Thorough study of all factors concerning water involved in producing steam.
2. Procedure for the proper treatment of boiler water.
3. Instruction of designated employees in making of essential control tests.
4. Periodic check up by Hall service engineers.
5. Periodic checking of samples by Hall Laboratories.
6. "Trouble shooting" that includes all service necessary as problems arise.

—all of which adds up to *boilers that stay on the line!*

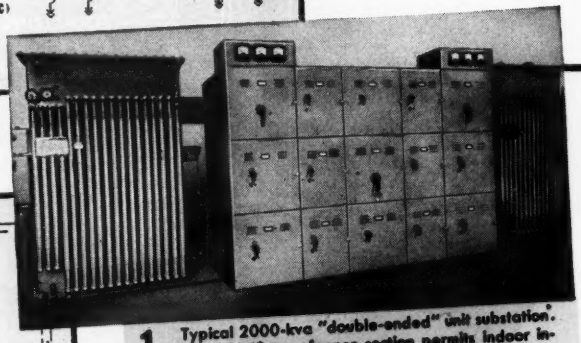
This War-Plant POWER SYSTEM HAS



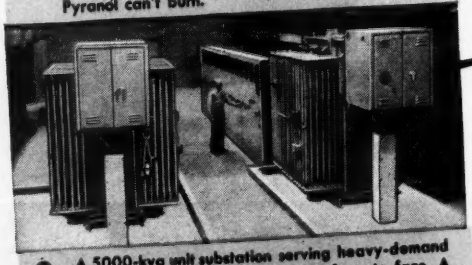


(Upper chart) A section of the "one-line diagram" for the main factory area, where 16 unit substations aggregating 30,000 kva are installed.

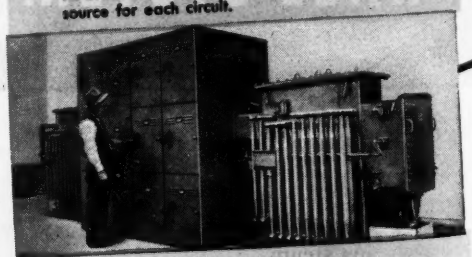
(Lower chart) "Close-up" of factory area served by one substation, showing 40-ft spacing of plug-in bus. Note that one substation serves 150,000 sq ft.



1. Typical 2000-kva "double-ended" unit substation. A Pyranol* transformer section permits indoor installation without creating a fire hazard, as Pyranol can't burn.



6. A 5000-kva unit substation serving heavy-demand area, with two sections mounted face to face. A tie breaker between the two gives a second power source for each circuit.



7. One of four 200-kva units serving the office area and basement, conveniently located in "penthouses" above the load centers.

*Trade-mark reg. U.S. Pat. Office

GE

LOAD-CENTER
Power Distribution Systems

LL Strong Points

Designed to save on materials and manpower, this load-center installation has made an unusual operating record for safe and reliable power distribution.

1 Load-center unit substations are employed throughout in a *secondary selective* arrangement. The two primary feeders to every substation start from different 13.8-kv buses. Every load circuit is backed up by two independent sources of power. Yet all equipment normally shares in carrying total load. All necessary immediate switching to maintain power supply can be done at 480 volts.

2 Primary distribution at 13.8 kv is handled by 3-conductor feeder cables carried in overhead troughs. Overhead installation saved manpower and materials. Inspection and relocation of cables are easy.

3 480 Y/277-volt secondary circuits serve local load-areas by means of plug-in bus. As substations are installed on the building roof, feeder taps to each plug-in bus are short and direct.

4 Fluorescent lighting of factory area is supplied from the same unit substations which serve factory operation. The 277-volt operation of lights from the line-to-neutral conductors of the system is highly economical, as compared with 120- or 208-volt circuits.

5 Capacitors, applied close to the machine-tool motor load, add to the carrying capacity of the substations. They are ceiling-mounted in blocks of 90-kva at the feeder taps of the plug-in bus throughout the main factory area. (10,000 kva, total).

6 Areas of heavy demand, requiring motors of 250 hp and larger, are served by separate substations which convert from 13.8 to 2.4 kv, again using the secondary-selective principle. Within these areas, small motor and lighting loads are powered by "sub-substations" which have 2.4-kv primary and 480/277-volt secondary.

7 An extensive office-building area is served by unit substations having secondary circuits at 208/120 volts.

POWER SYSTEMS LIKE THIS protect operating continuity and give any plant greater flexibility to meet changing needs. They can be applied to old plants as a complete modernization project, or step by step without interrupting production. The over-all installed cost is fully predictable.

G-E application engineers will be glad to give you recommendations based on highly successful wartime installations. *General Electric Company, Schenectady 5, N. Y.*

Buy all the BONDS you can—and *keep all you buy*

GENERAL ELECTRIC

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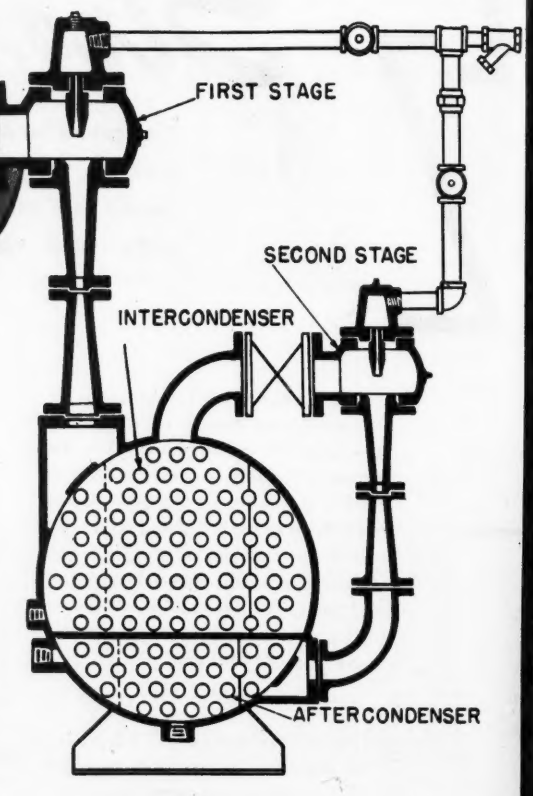
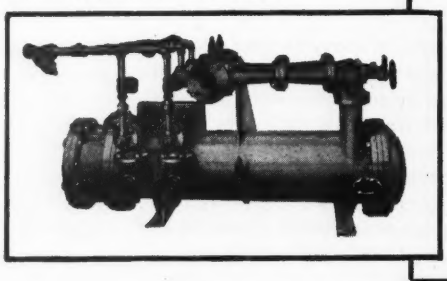
COMPACT ARRANGEMENT
★ SPECIFIC PERFORMANCE ★



LUMMUS STEAM JET AIR EJECTOR



LUMMUS EQUIPMENT

HEAT EXCHANGERS
•
PROCESS CONDENSERS
•
REBOILERS
•
STEAM GENERATORS
•
STEAM JET REFRIGERATION
•
STEAM SURFACE CONDENSERS
•
BAROMETRIC CONDENSERS
•
STEAM JET AIR EJECTORS
•
EVAPORATORS
•
BOILER BLOWDOWN HEAT EXCHANGERS
•
FUEL OIL HEATERS
•
LUBRICATING OIL COOLERS
•
PIPE LINE COOLERS
•
FEED WATER HEATERS
•
JACKET WATER COOLERS

Lummus experience . . . in designing and fabricating steam jet air ejectors to meet the requirements of all Lummus steam surface condensers — or the specific operating conditions of individual installations . . . is your guarantee of efficient air removal. .

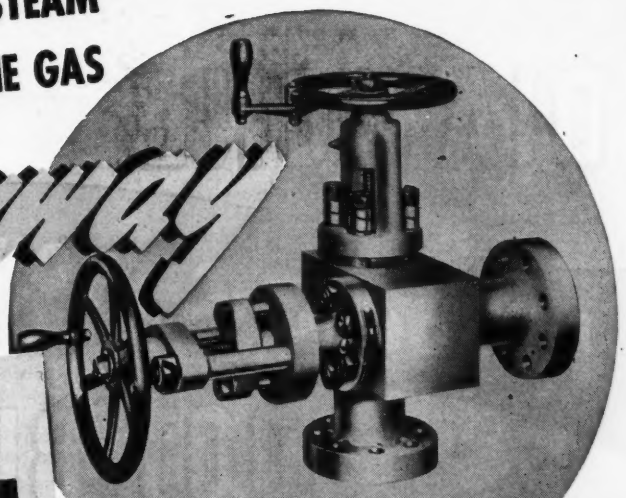
Inter-and-after condensers combined in one shell provide notable economies to space requirements and to installation, maintenance and initial costs. Units can be supplied with separate condensers, if desired. Efficient design assures exceptionally stable operating characteristics with minimum steam consumption. The fact that many early Lummus features have become standard practice in steam jet air ejector construction is evidence of Lummus design leadership.

Lummus engineering service is always available for the study of specific heat exchanger problems. For further information write to: The Lummus Company, 420 Lexington Avenue, New York 17, N. Y.

LUMMUS
HEAT EXCHANGERS

WHERE HIGH PRESSURE STEAM HELPS MAKE HIGH OCTANE GAS

It's Yarway



YARWAY UNIT-TANDEM VALVE — Flanged Type
(Installation below shows Socket-Welding Type)

UNIT TANDEMS!

When this great California aviation gasoline refinery went "on stream" recently, it was only natural that Yarway Unit Tandem Blow-Off Valves should be on the job at the giant boilers in the high pressure steam plant.

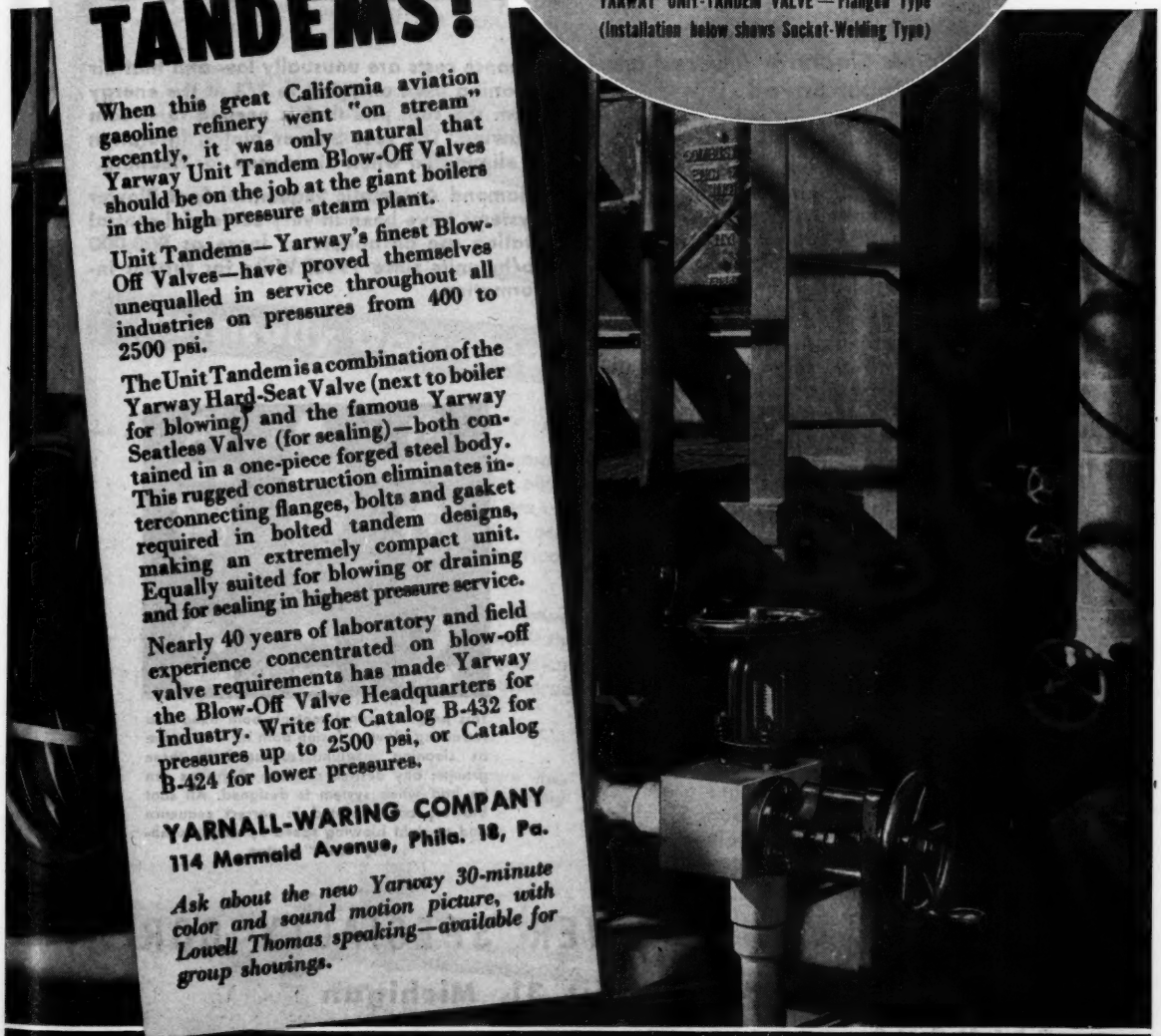
Unit Tandems—Yarway's finest Blow-Off Valves—have proved themselves unequalled in service throughout all industries on pressures from 400 to 2500 psi.

The Unit Tandem is a combination of the Yarway Hard-Seat Valve (next to boiler for blowing) and the famous Yarway Seatless Valve (for sealing)—both contained in a one-piece forged steel body. This rugged construction eliminates interconnecting flanges, bolts and gasket required in bolted tandem designs, making an extremely compact unit. Equally suited for blowing or draining and for sealing in highest pressure service.

Nearly 40 years of laboratory and field experience concentrated on blow-off valve requirements has made Yarway the Blow-Off Valve Headquarters for Industry. Write for Catalog B-432 for pressures up to 2500 psi, or Catalog B-424 for lower pressures.

YARNALL-WARING COMPANY
114 Mermaid Avenue, Phila. 18, Pa.

Ask about the new Yarway 30-minute color and sound motion picture, with Lowell Thomas speaking—available for group showings.



YARWAY BLOW-OFF VALVES

DIAMOND

AUTOMATIC SEQUENTIAL

SOOT BLOWERS

Correct Boiler Cleaning Assured and Labor Saved

When a boiler is equipped with a Diamond Automatic Sequential Soot Blower System, all blowers operate in proper sequence and at the right blowing speed. No blower can be overlooked or incorrectly operated by a careless attendant. The automatic operation saves considerable labor cost because it entirely eliminates the need for an operator.

The program panel shown at the right controls both retracting and nonretracting blowers (using air or steam or both as the cleaning medium) arranged in groups. One "start" button controls all groups for the entire boiler, superheater, economizer and air heater. Any group can be operated independently of other groups by simply throwing a switch on the panel. Blowing sequence of the units in any group can also be easily altered to suit changed conditions.

Air Offers Additional Advantages

While the saving in labor and improved boiler cleaning are characteristics of all Diamond Automatic Sequential Soot Blower Systems, those using compressed air as the cleaning medium have the additional advantage of eliminating feed water makeup. This is particularly important where makeup water is a problem. Compressed air has a greater density than steam and therefore provides better cleaning. Experience gained during several years' operation proves that maintenance costs are unusually low and that air cleaning used only 1/3 to 2/3 of the energy from the coal pile that is needed for steam blowing. The soot blower piping insulation is eliminated when air is used for cleaning.

Diamond Automatic Sequential Soot Blower Systems have been in very successful central station use on boilers as large as 900,000 lb/hr units since 1940. Write for further information.

This program panel controls both fixed and retracting blowers (using both air and steam as cleaning medium) arranged in three groups; any desired number of groups can be had when system is designed. All soot blowers are operated in correct sequence and at right blowing speed by simply pushing "start" button.

DIAMOND POWER SPECIALTY CORP.

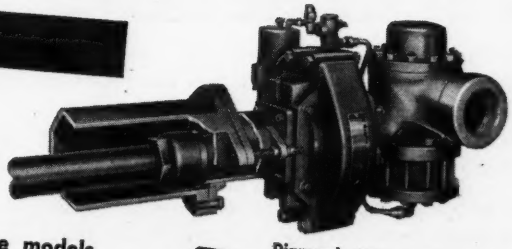
Detroit 31, Michigan

DIAMOND SPECIALTY LTD. • Windsor, Ontario

Air Operated

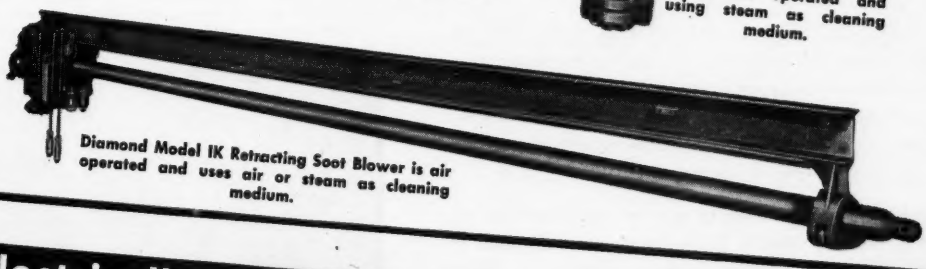
Models of Diamond Soot Blowers that use steam for the cleaning medium as well as those using air for cleaning are operated by air. There are models other than those illustrated that can be air operated . . . for example the Model IF shown below electrically operated.

The operation and control of the various blowers used in Diamond Automatic Sequential Soot Blower Systems are sufficiently flexible to meet the requirements and preferences of the individual steam plant.



Diamond "Air Puff" Soot Blower is air operated and uses air as cleaning medium.

Diamond Model G9B Soot Blower air operated and using steam as cleaning medium.



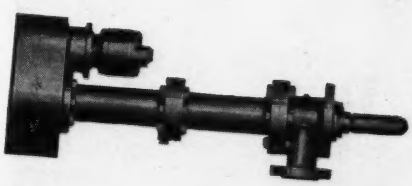
Diamond Model IK Retracting Soot Blower is air operated and uses air or steam as cleaning medium.

Electrically Operated

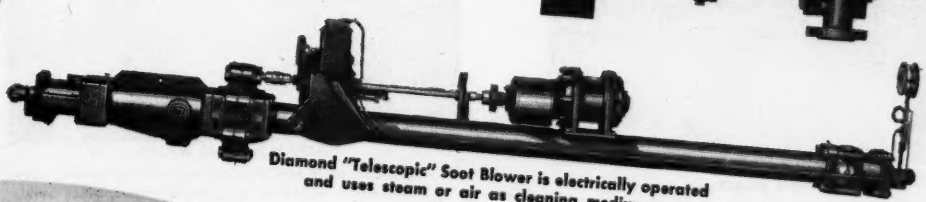
Illustrated here are representative models of Diamond Soot Blowers that are electrically operated; both air and steam are used as the cleaning medium. There are other models that can be operated electrically when preferred.

Diamond Automatic Sequential Soot Blower Systems have sufficient variety to permit the selection of those models that are particularly suited to the conditions encountered in the individual steam plant.

Diamond Model G9B Soot Blower electrically operated and using steam as cleaning medium.



Diamond Model IF Retracting Soot Blower electrically operated and using air as cleaning medium.



Diamond "Telescopic" Soot Blower is electrically operated and uses steam or air as cleaning medium.

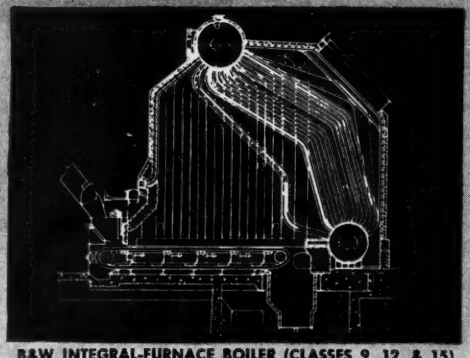
PRACTICAL PLANS for

In the wake of this war will come new jobs for steam . . . new opportunities . . . new problems . . . keener competition . . . that will put renewed emphasis on power plant reliability, efficiency, and operating costs.

When the urgency of war production begins to unwind into the pattern of peacetime competition, power plant engineers will want to be ready in advance with step-by-step plans for urgently needed modernization and expansion of existing facilities. Properly drawn, such plans will help speed reconversion of their own industries and hasten action in providing for fully integrated power services having the high overall efficiency and flexibility for changing conditions that future operations will demand.

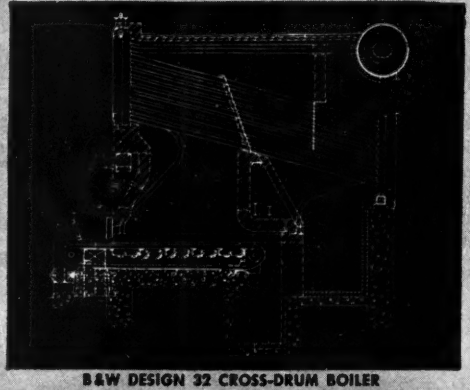
Thinking and planning for tomorrow *today* is a job B&W engineers are ready to tackle in partnership with power engineers of industry. Their long leadership in meeting steam power requirements has been greatly augmented by much more valuable experience gained in serving the industry war needs.

When the time comes to specify equipment for the future, there is a B&W boiler for any combination of conditions . . . capacity, pressure, temperature, feedwater, fuel and space . . . to be met. Whatever the type needed, it is built for the job, thus assuring the highest standards of performance, continuity of service, high overall station economy and greatest return on the investment.



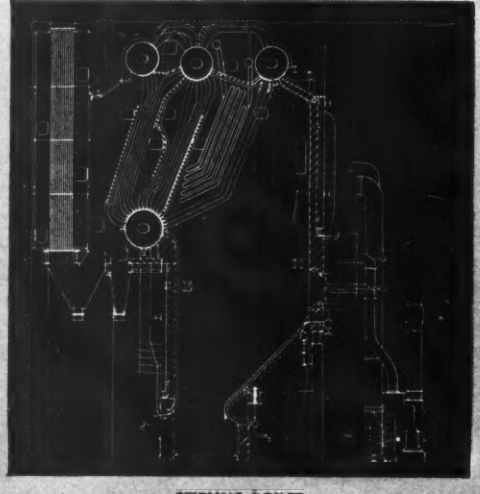
B&W INTEGRAL-FURNACE BOILER (CLASSES 9, 12, & 15)

This Integral-Furnace Boiler is available for firing with stokers or with oil, and in sizes ranging from 1353 to 6506 sq. ft. of heating surface. Having a water-cooled furnace of special design, this boiler provides the dependability of central-station boilers, with efficient and smokeless combustion.



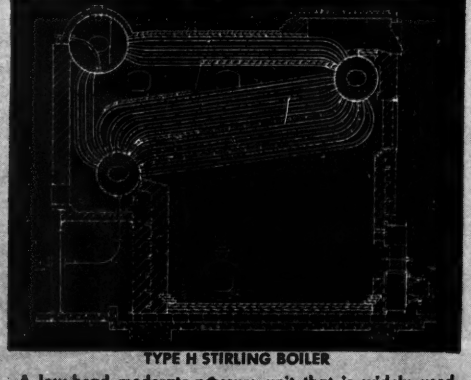
B&W DESIGN 32 CROSS-DRUM BOILER

This unit is widely used in small and medium-size power plants where refractory furnaces are suitable. It provides the advantages of the straight-tube, sectional-header construction used in B&W Cross-Drum Boilers designed for larger capacities.



STIRLING BOILER

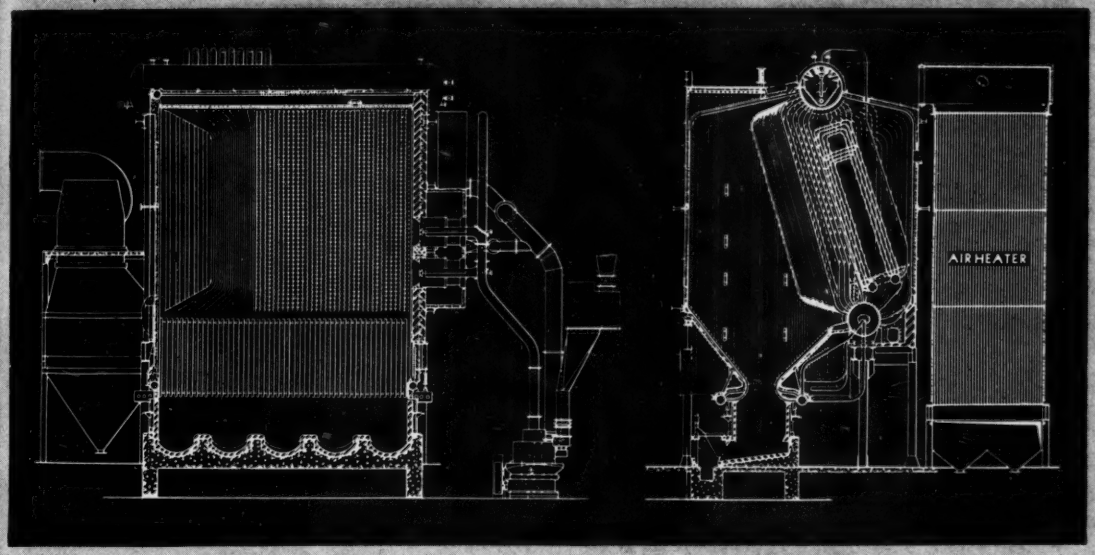
The Stirling Boiler fully meets the requirements of modern operating conditions. It readily responds to sudden and heavy demands for steam, and delivers dry steam at relatively high ratings when operated with water having a high concentration of solids. May be fired with any fuel.



TYPE H STIRLING BOILER

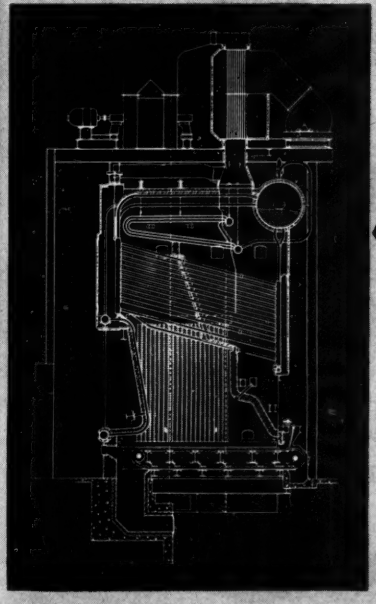
A low-head moderate-pressure unit that is widely used in small industrial plants, institutions, hotels, office buildings and to meet other similar requirements. Available in capacities ranging from 1500 to 30,000 lb. steam per hr. and for firing with any fuel. The furnace, usually of refractory, provides the necessary degree of dependability.

PEACETIME POWER . . .



INTEGRAL-FURNACE BOILER

The Integral-Furnace Boiler is a completely co-ordinated unit built in capacities up to 250,000 lb. steam per hr. and for the pressures and temperatures required by the most up-to-date and efficient prime movers. It is designed to burn pulverized solid fuels, oil, or gas, singly or in combination, thus utilizing at high combustion efficiency the least expensive fuel obtainable in any locality.

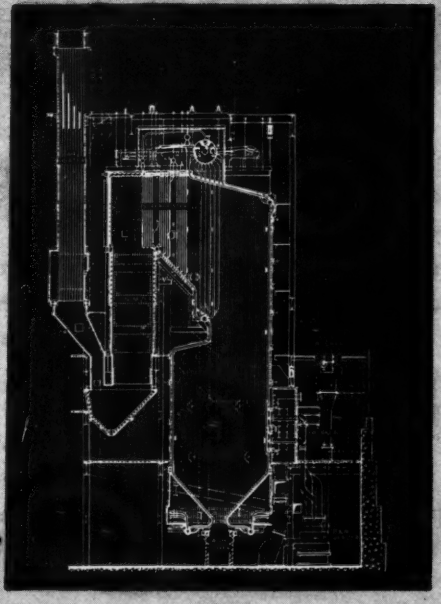


B&W CROSS-DRUM BOILER

This straight-tube sectional-header boiler is noted for its dependability, long life, and ability to deliver dry steam at high ratings. Can be readily inspected and cleaned.

CENTRAL-STATION BOILERS

High-duty boilers for central-station service are available in several basic designs to meet the requirements of individual stations. The Radiant boiler unit illustrated is typical of some of the units now operating at high rates in utility plants.



THE BABCOCK & WILCOX CO. • 85 LIBERTY STREET, NEW YORK 6, N. Y.

BABCOCK & WILCOX

G-294F

Why FREIGHT ELEVATORS are important!

BEHIND this busy scene, freight elevators are constantly on the job . . . keeping supplies and even the trucks themselves moving on schedule . . . without bottlenecks . . . without confusion.

For intensive service, the elevators should be high speed, automatic in operation and provided with power operated doors. Such equipment will compensate for some of the time lost in loading and unloading operations.

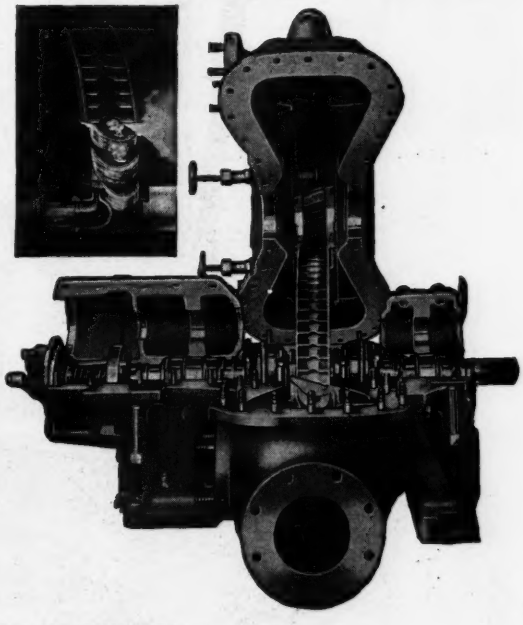
If conditions require, freight elevators can be dispatched to predetermined floors to suit any cycle of operation. Also, they do not necessarily require regular attendants.

Your nearest Otis representative is now available to assist you and your Architect in making preliminary elevator plans and studies. For the finest in vertical transportation tomorrow, call your Otis representative TODAY!

Otis ELEVATOR COMPANY
OFFICES IN ALL PRINCIPAL CITIES

TERRY

Action of steam in Terry solid wheel and reversing chamber.



Typical Terry Solid Wheel Turbine with casing cover and bearing caps raised. Note ruggedness and the accessibility of all parts. Units of this type are used to drive all types of power plant auxiliary equipment built in sizes from 5 H.P. to 2000 H.P.

THE TERRY WHEEL TURBINE- FOR AUXILIARY DRIVE— OFFERS MANY ADVANTAGES

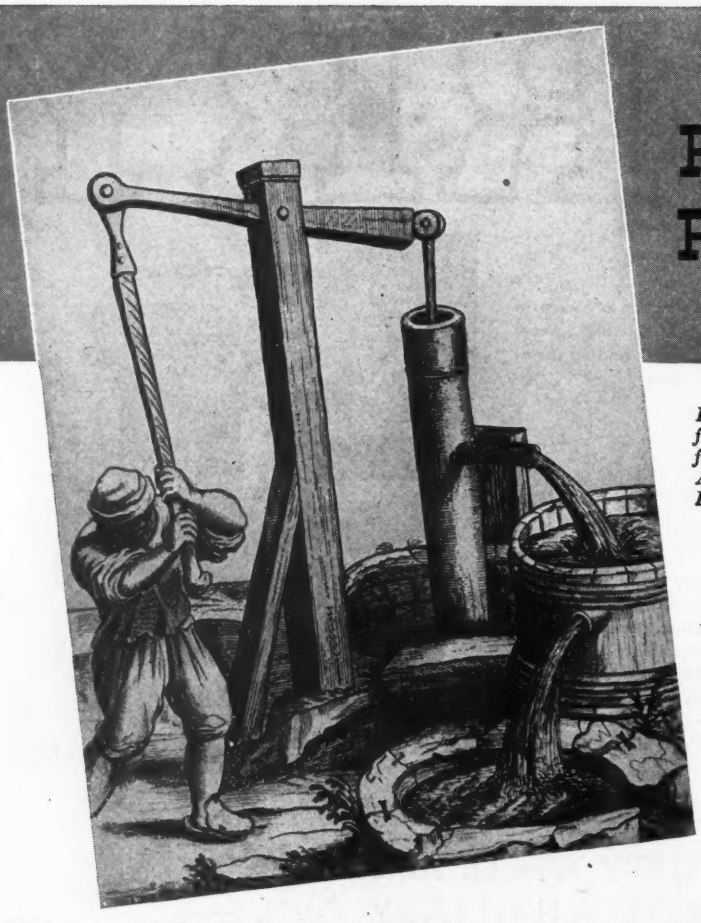
FROM THE SMALLEST TO THE LARGEST, THESE RELIABLE TURBINES HAVE—

- ★ Indestructible one piece wheel.
- ★ Large radial and axial clearances.
- ★ Double rim protected blading.
- ★ Individual nozzle control.
- ★ Dependable and durable governor.
- ★ Heavy dust-proof bearing and governor housing.
- ★ Independent overspeed trip with separate valve.
- ★ Sturdy casing design.
- ★ Strong and easily inspected steam strainer.
- ★ Truly accessible construction, which makes inspection of the interior parts a simple matter.

FOR FULL DETAILS ASK FOR BULLETIN S-116.

T-1157

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



PRIMITIVE PUMP—1650

Primitive pump used on an Italian farm during the 17th Century—from a copper engraving by Athanasius Kircher, 1601-1680. Illustration from Bettmann Archive.

That's One Way To Pump Water

GARLOCK LATTICE-BRAID PACKING

The unique structural design imparts semi-automatic pressure action. Available in several styles for service on pumps and other equipment.

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada, Ltd., Montreal, Que.

The lift pump used by the farmers in Europe some four hundred years ago seemed to do a fairly good job according to this old-time illustration. But it's a far cry from the modern high-pressure and high-speed pumps in use today. Pump valves, packings, gaskets and oil seals have also improved through the years—keeping pace with engineering advancements in the equipment in which they are used. Today the complete line of Garlock products fills every need of modern industry.

Garlock

SIMPLEX VENTURI TUBES

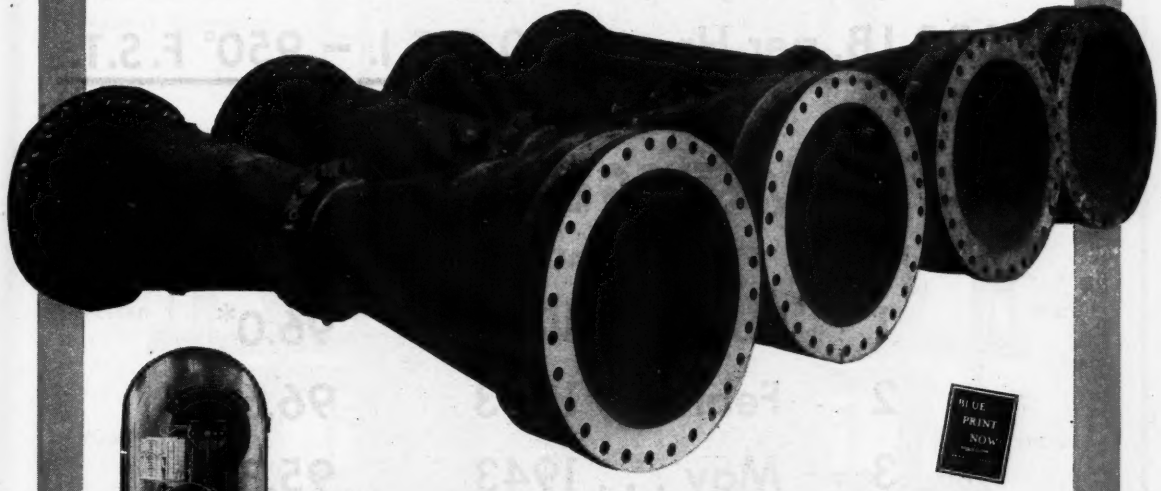
the ULTIMATE IN *Venturi Efficiency*

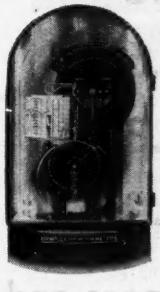
For a given flow of water, the Simplex Venturi and its Simplex Meter will measure with the least loss of energy, and the greatest accuracy over the widest range of flow!

The high constant efficiency with which the Simplex Venturi utilizes the differential head which it creates, has been proved by over 40 years of research and manufacture.

This highly-engineered primary device assures minimum head loss and normal, dependable coefficients. The unit is homologous in type and form; the tube throat is bronze-lined with extremely accurate piezometer taps; the pressure belt type design is essential to high and unvarying accuracy.

The venturi tube is accepted as being the most efficient of primary devices. . . . Installations as part of pipes and conduits of cast material and of fabricated structure, have proved the Simplex Venturi to be unsurpassed in installed operating efficiency!





THE MO METER COMPLETES THE PICTURE

The "MO" is the "Master" Meter that converts the differential head created by the Simplex Venturi into rates of flow and indicates, records, and totalizes that flow with the maximum overall accuracy. This combination of Simplex primary device and MO Meter provides a standard of operating efficiency for the flow measurement of water, sewage and process liquids ni many municipal and industrial plants. The MO Meter is of such high accuracy that it may be utilized for testing the accuracy of other metering equipment. Write for Bulletin 300 — "The Simplex MO Meter."

SIMPLEX VALVE & METER CO.
6783 UPLAND STREET, PHILADELPHIA 42, PENNA.

Availability Record of NEW DESIGN TWIN FURNACE Steam Generators

FOUR UNITS

with Separately Fired Superheater Furnaces

450,000 LB. per Hr. – 1550 P. S. I. – 950° F. S. T.

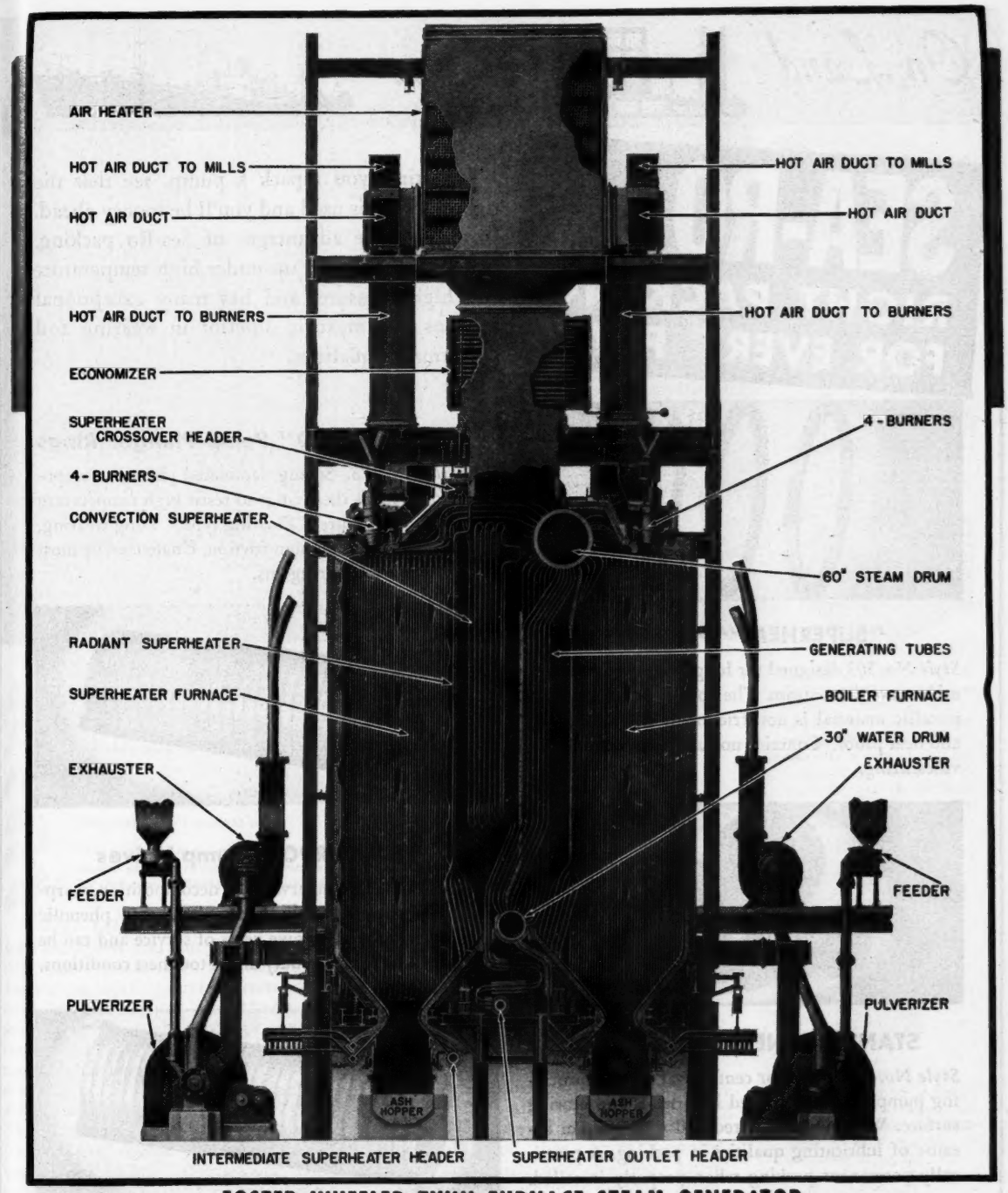
96.1% AVERAGE AVAILABILITY

NO.	STARTING MONTH	AVAILABILITY
1	January 1943	96.0*
2	February 1943	96.6*
3	May . . . 1943	95.8*
4	June . . . 1943	96.0*

*Including outages to make necessary changes and adjustments to perfect a new design.

FOSTER WHEELER CORPORATION

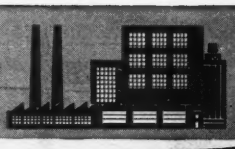
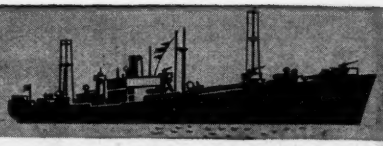
FW FOSTER



FOSTER WHEELER TWIN FURNACE STEAM GENERATOR

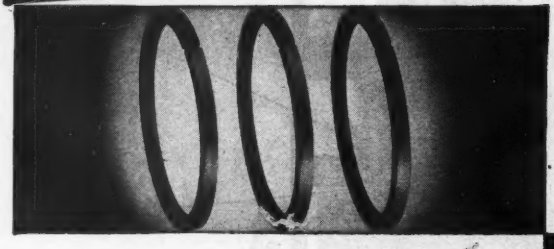
165 Broadway — New York 6, N. Y.

WHEELER

On Land  *or Sea* 

SEA-RO has the RIGHT PACKING FOR EVERY PUMP

Next time you repack a pump, see that the right packing is used and you'll be money ahead. Investigate the advantages of Sea-Ro packing. You'll find it stands up under high temperature and high pressure, and has many exceptional features that make it superior in wearing and performance qualities.

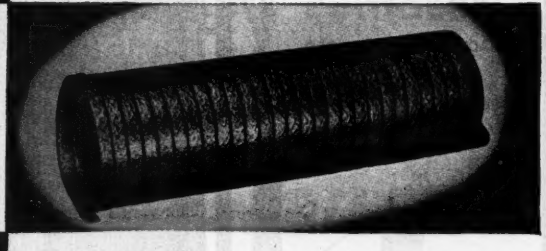


"GRAPHITIZED" Pump Plunger Rings

Style No. 528. Strong, laminated phenolic composition enables these rings to resist high temperature and high pressure. "Floating type." Long wearing, light-weight, minimum friction. Unaffected by most solvents, oil and reagents.

"SUPERHEAT" PACKING

Style No. 503 designed for long trouble-free service under superheat steam. The core, a flexible plastic metallic material is anti-frictional, self-lubricating and heat proof. Contains no rubber, therefore non-vulcanizing.

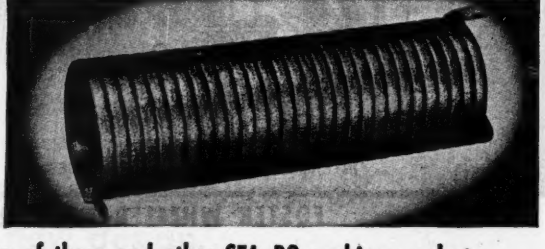


ALL-PURPOSE Pump Valves

Style No. 535. Impervious to decomposition, warping or chemical action, these laminated phenolic composition valves give years of service and can be resurfaced for extra duty under toughest conditions.

STANDARD NEK-SEAL Packing

Style No. 501, ideal for centrifugal and reciprocating pumps. Once installed it forms a fine bearing surface. Wear on rods is reduced to minimum because of lubricating qualities in packing. A practically permanent packing when properly installed.



Send for new CATALOGUE giving full description of these and other SEA-RO packing products.

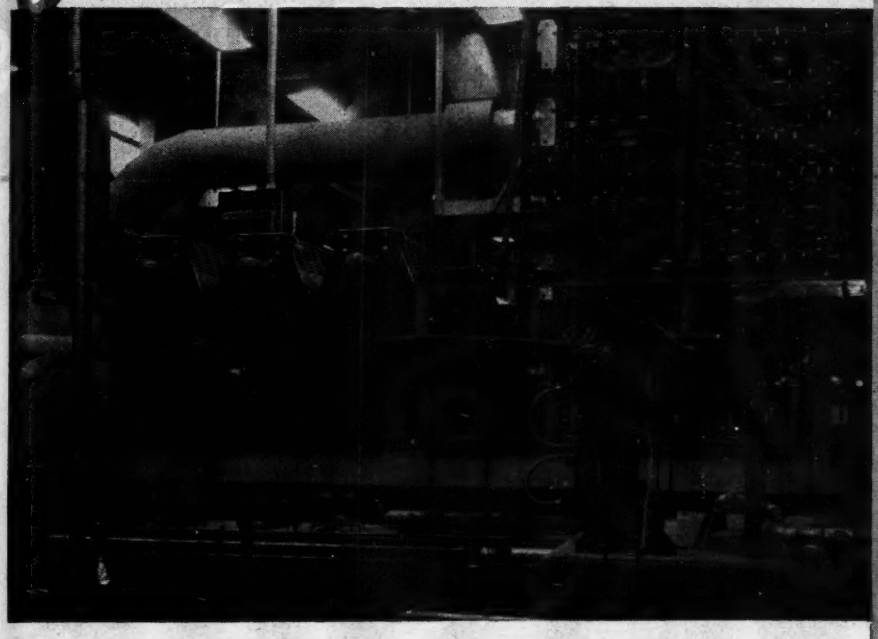
SEA-RO

PUMP PLUNGER RINGS
NEK-SEAL PACKING

SEA-RO PACKING CO. • WOOD-RIDGE, NEW JERSEY

Agents:
WEISE ENG. & EQUIP. CO. . . . . 172 HIGH STREET, BOSTON, MASS.
VICTORY SUPPLY & MFG. CO. . . 273 WEST 7th STREET, SAN PEDRO, CALIF.
CORDES BROS. . . . . 200 DAVIS STREET, SAN FRANCISCO, CALIF.

6 THINGS TO NOTICE in this picture



1. The dry-type transformers are close to the load, yet out of the way.
2. There are no long runs of heavy copper.
3. No expensive, space-stealing fireproof vaults are required.
4. The transformers are totally metal enclosed for safety.
5. Little installation space is used.
6. The slanted-louver construction, top and bottom, to assure cool operation. (The "chimney effect" produced by this construction carries away heat rapidly.)

THEY'RE ALL ADVANTAGES YOU CAN HAVE WITH

G-E TYPE D TRANSFORMERS

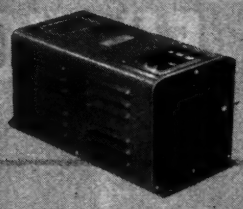
DO YOU REALIZE the many jobs on which you can use small G-E dry-type transformers to advantage? Insulating lighting circuits from power circuits, boosting low line voltage, and supplying the right voltage for the most economical operation of motors, machine tools, and welding apparatus are only a few of their many money-saving applications.

Stay cool; save space—Type D transformers are cooled by natural-draft ventilation. Their unique case construction aids the flow of ventilating air through the transformer coils. They can be installed against a wall or close to other units with little or no effect on the temperature rise of the transformer. Because of this fact, considerable space can be saved, especially when a number of these transformers are to be banked. (For example, the above installation in a midwestern plant. Here, only a small platform is required to take care of six 100-kva units to supply 230-volt annealing furnaces.)

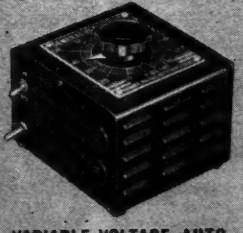
Easy to install; maintenance negligible—As these transformers are small, compact, and lightweight, and do not require a fireproof vault, they can be installed almost anywhere you wish. The ease of disassembly and reassembly of case parts permits quick inspection and cleaning, when necessary. Operating records show that little or no maintenance is required.

Type D transformers are available in ratings up to and including 100 kva—600 volts and below. For further information, ask for Bulletin GEA-897. *General Electric Company, Schenectady 5, N. Y.*

OTHER G-E AIDS TO BETTER VOLTAGE



VOLTAGE STABILIZER—Automatically provides a constant 115-volt supply to a given load, on circuits varying from 95 to 130 volts. Ratings from 50 to 5000 va. Ideal for precision laboratory or manufacturing processes, or built into such equipment as radio transmitters.



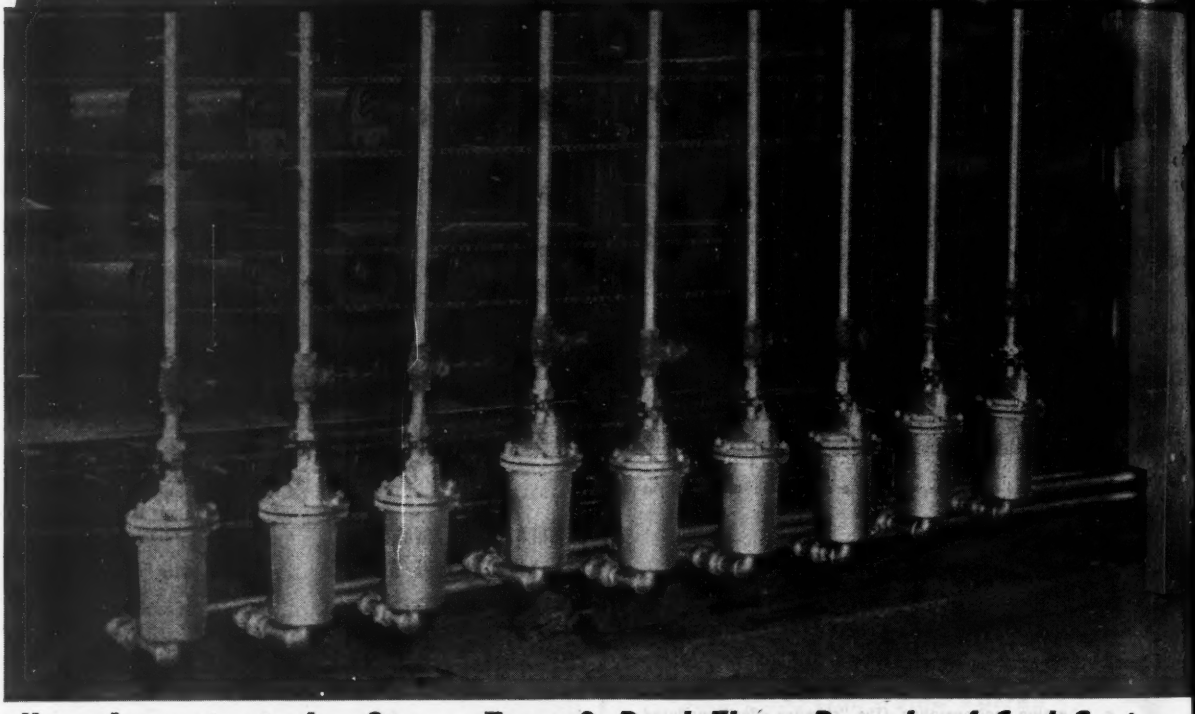
VARIABLE-VOLTAGE AUTO-TRANSFORMER—Provides smooth, adjustable control of voltage, current, light, temperature, power, and speed at a turn of the dial. Ratings from 243 to 810 va. Ideal for use in factories, laboratories, and assembled with other equipment.

AIR-COOLED REGULATORS—Automatic type: for secondary circuits (10% regulation, raise and lower). Remote-motor or hand operated: for laboratory or testing (100% raise and lower). Ratings up to 12 kva, 600 volts.

THE RIGHT VOLTAGE AT THE RIGHT PLACE DOES THE JOB **BETTER**

GENERAL ELECTRIC

"ENOUGH COAL FOR 3000 YEARS



How Important *Are* Steam Traps? *Read These Records of Coal Savings*

LAUNDRY CUTS FUEL COSTS 35% Peerless Laundries, Ltd., Los Angeles, one of the world's largest laundries, reduced heating-up time by 30 minutes, reduced maintenance costs 8% by installing Armstrong Traps.

27% FUEL SAVING AT HOTEL—Mount Washington Hotel, Bretton Woods, N. H., experienced 27% reduction in fuel consumption the first year after Armstrong Traps were installed.

CUTS COAL BILL $650 ANNUALLY—A Huntingburg, Ind., firm spent $417 for Amrstrong Traps and saved $650 on coal the first year they were installed.

STORE EQUIPMENT CONCERN SAVES 170 TONS COAL—At the Northwestern Store Equipment Corp., Milwaukee, Wis., Armstrong Traps save 170 tons of coal per year; heating-up time on wood drying kilns cut from 5½ hours to 2½ hours, and back pressure on steam engine used to drive line shafting dropped from 7 - 10 lbs. to 2 lbs.

GREENHOUSE SAVES $1067 ON COAL IN ONE YEAR by using Armstrong Traps. This unit trap installation saved 220 tons of coal per year.

HIGH SCHOOL CUTS COAL CONSUMPTION 50% — The Springfield City High School, Springfield, Ohio, reduced coal consumption from 8-9 tons per day to 4, by installing 30 Armstrong Traps.

TRAPPING SAVES MUNICIPALITY $2600 A YEAR—Oil City, Pa. saved exactly $2651.42 in fuel the first year Armstrong Traps were installed at the city water pumping station.

PLYWOOD COMPANY SAVES CARLOAD OF COAL PER WEEK—Atlas Plywood Corp. of Canada Ltd., Waterloo, Quebec, effected this saving by installing Armstrong Traps. Believe it or not this company has effected a 100% savings on coal purchases, since the coal was supplementary to a waste wood supply.

ARMSTRONG SAVES CANVAS GOODS MANUFACTURER 50% FUEL COSTS—Couch Bros. Mfg. Co., East Point, Ga., used only 4½ tons coal for heating purposes instead of 9, after installing Armstrong Traps.

ARMSTRONG *Inverted Bucket*

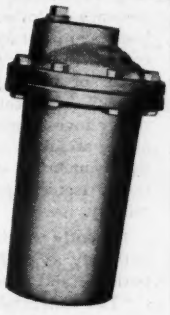
. . . may not do you any good today!

conserve it with ARMSTRONG STEAM TRAPS

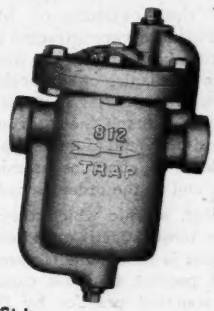
**A recent estimate of bituminous coal deposits in the United States indicated that there is enough for another 3000 years, but it's the coal in your bin that counts today.*

Armstrong Traps save coal because they don't leak steam . . . because they discharge condensate as rapidly as it accumulates . . . because they automatically vent air—thereby allowing the steam to give up its heat where it is supposed to for productive results.

Armstrong Steam Traps are available for all services and all pressures. Sold by leading distributors and jobbers everywhere. Guaranteed to satisfy. Over a million in use. Write for 36-page STEAM TRAP BOOK.



Bottom inlet Top outlet



Side inlet — Side outlet

FEATURES:

1. Stainless Steel bucket and lever system.
2. Chrome steel valve and seat — hardened, ground and lapped.
3. Frictionless leverage system.
4. Swirling action of condensate cleans out all ordinary dirt and scale.
5. Choice of body styles.
6. Automatic air elimination.
7. Every trap factory tested.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Michigan

STEAM TRAPS for POWER PROCESS HEATING

COPPER ALLOY BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company — "Bridgeport" BRASS CO. — *Headquarters for BRASS, BRONZE, and COPPER*

Arsenic as a Corrosion Inhibitor

Destroying the Myth of Intercrystalline Attack

The use of arsenic as a dezincification inhibitor for Admiralty condenser tubing and 70-30 brass was reported as far back as 1924 by the well-known metallurgists, Bengough and May in the British Institute of Metals as part of the Seventh Report to the Corrosion Research Committee of the Institute of Metals (British). This discovery attracted world-wide attention because of their masterly work on the mechanics of dezincification and methods of preventing it. Aside from arsenic they also found that "tin, nickel, tungsten, antimony and aluminum all had the same kind of effect as arsenic but less intense and in the order named."

As a result, arsenic which they considered the most effective inhibitor of dezincification is now added in amounts up to 0.04 percent to brass condenser tubing as standard practice by British manufacturers. It was also adopted as standard practice by Bridgeport Brass Company and most of the larger American manufacturers about 1936. These investigators also developed aluminum brass for condenser tubes and included arsenic as an inhibitor.

Recently, investigations by two American manufacturers indicated that antimony and phosphorus are corrosion inhibitors. In obtaining their U. S. patents for adding these other dezincification inhibitors, the inventors claimed that their inhibitors are superior to arsenic because they prevent the occurrence of "intercrystalline attack" which they stated is characteristic of brasses containing small amounts of arsenic added intentionally to prevent dezincification. Their claims were based on accelerated corrosion tests which were conducted with solutions of several concentrations of cupric chloride. No experiments under actual service conditions, as found in seaboard power plants, marine condensers, heat exchangers and oil refineries, were conducted to substantiate any of their claims.

In recent months we have come across rumors to the effect that Arsenical Admiralty is subject to "intercrystalline attack" and naturally we wish to run them down. In Bridgeport Brass Company's long experience, as well as in the experience of other companies who have been manufacturing arsenical Admiralty condenser tubes for many years, no evidence of the mythical "intercrystalline attack" has been found. Several laboratory investigators, using cupric chloride as the attacking agent, have reported the development of intergranular cracking in both Arsenical Admiralty and plain Admiralty.

Recently we checked with a prominent authority as to British practice and experience and received the following:

"The beneficial effect of small amounts of arsenic in brass in preventing dezincification of the alloy has been widely known for many years. In this country it is, and has been for several years, quite a common practice to add arsenic to the extent of about 0.02—0.04 percent not only to aluminum brass, but to other brass alloys for the manufacture of condenser tubes.

"We are not acquainted with any evidence arising either in the course of experiments or in service which would indicate that the presence of this amount of arsenic is in any way injurious or detrimental to the alloy, or that it gives rise to any kind of intercrystalline failure."

Regardless of the use of other corrosion inhibitors besides arsenic which are being advocated by some manufacturers, Bridgeport Brass Company intends to continue to supply Arsenical Admiralty, Arsenical Muntz, and Arsenical Aluminum Brass because experience has shown that the addition of arsenic is excellent as a dezincification inhibitor. We have yet to run across a single case of intercrystalline attack and would appreciate it if our friends will help us spike the rumor or bring the offender out in the open where we can all take a good look at it, if it is in existence.

Cupro Nickel Now Released For General Use

It has been announced that limitation order L-154 schedule II which restricted the use of cupro nickel tubes in steam surface condensers has been revoked, and that cupro nickel is now available for general use.

70-30 cupro nickel condenser tubing made to Navy specifications 44T39a, is the standard alloy specified by the U. S. Navy for all battleships and many other types of vessels. Besides excellent resistance to impingement attack, this alloy withstands erosion and corrosion in most cases better than brass. It was adopted by the Navy after numerous tests indicated that Admiralty condenser tubing could not stand up satisfactorily for fast steam turbine-propelled vessels which depend on condensers that produce a high vacuum and operate with high water velocities. Under such conditions tubing is exposed to both corrosion and erosion caused by the impingement of air bubbles associated with water of high velocity and turbulence. 70-30 cupro nickel made to Navy specifications 44T39a fulfills the requirements of the U. S. Bureau of Ships which calls for the presence of 0.6 maximum percent iron and over 0.5 percent manganese.

70-30 cupro nickel withstands elevated temperatures better than brass and is used for feed water heaters, heat exchangers and evaporators where good corrosion resistance is imperative. This alloy is said to be immune to season or stress corrosion cracking caused by the combined action of moist ammonia, oxygen, stress and time. Since cupro nickel has a lower specific thermal conductivity than brass, some designers of condensers provide 10 percent additional condensing surface as compared to brass tubes, to allow a safe margin for this difference. However, there are engineers who claim that the thermal conductivity has little bearing on the rate of heat flow from one fluid to another through such a metal wall.

Because this alloy has superior properties to most metals and alloys, cupro nickel is being carefully considered for many applications involving corrosion too severe for ordinary metals. This is in line with the present tendency to fight the ravages of corrosion with better materials which may be higher in first cost, but which are most economical when length of service and reduction in maintenance are taken into account.

Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

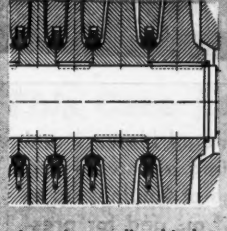
BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

ESTABLISHED 1865

SIMPLIFIED *More Efficient* STEAM SEALING

HENDY Turbine Labyrinth Seals are another dividend-paying feature

This simplified step-cut labyrinth steam seal is an exclusive feature of Hendy turbines that not only reduces interstage leakage but also contributes to shaft rigidity and rotor disk strength. A shorter and stronger turbine is possible with this method of sealing, since each disk is butted against the adjoining one.



The four-piece sealing blocks are soft leaded bronze, flexibly located, with leaf springs applying pressure from the diaphragm grooves. This feature in Hendy turbines contributes to longer operating life and higher over-all efficiency. Watch succeeding advertisements for other dividend-paying Hendy features.

When requesting data on Hendy turbines or turbo-generating plants please indicate type of service involved, electrical requirements, and steam conditions.

The development of this highly efficient steam-sealing method is the result of Hendy experience gained through the mass production of 4000, 6000 and 8500-hp turbines, and large numbers of turbo-generator sets for the Maritime Commission.

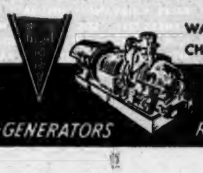
Simplified governor and speed control, and rocker-shaft operation of the valve mechanism are other Hendy turbine features. Combined with the labyrinth seals and simplification of design throughout the entire unit, they raise operating efficiencies and reduce maintenance and service problems. Two-color reprints showing details of these features are available upon your request.

Hendy turbines are available as separate power units for marine or industrial applications, or, as complete turbo-generating plants in a wide range of sizes.

Submit your power problem to any Hendy office. They will gladly help in its solution.

JOSHUA HENDY IRON WORKS
ESTABLISHED 1856
SUNNYVALE, CALIFORNIA

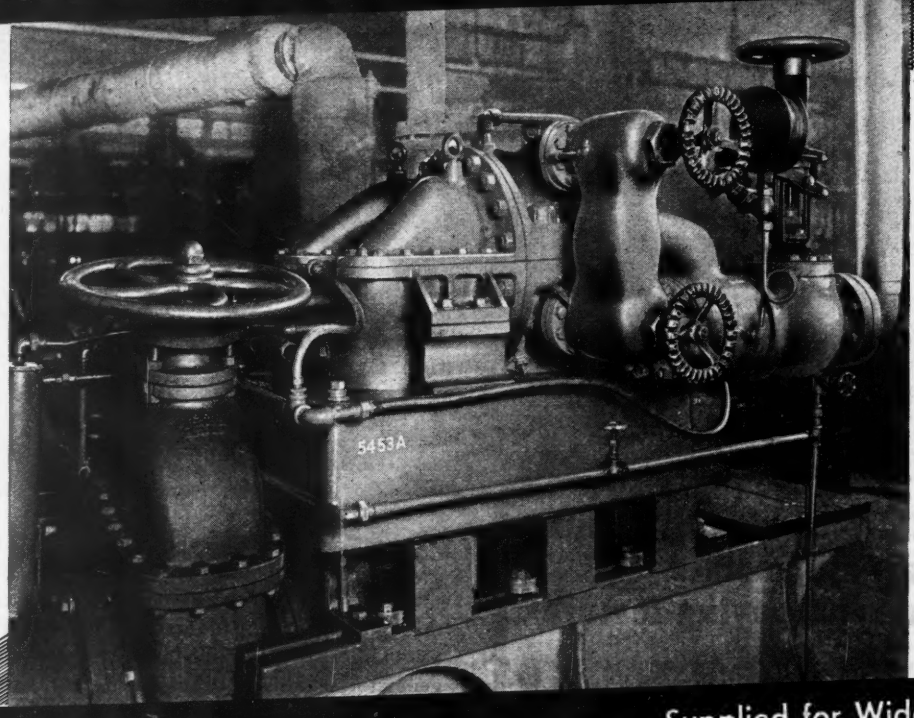
Branch Offices: WASHINGTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • NEW YORK • LOS ANGELES • DETROIT • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • BOSTON



TURBO-GENERATORS REDUCTION GEARS STEAM TURBINES DIESEL ENGINES

87-70-8

THIS DE LAVAL UNIT
COMPRESSES S-T-E-A-M



OTHER DE LAVAL COMPRESSORS Supplied for Wide Variety of Services

The above single-shaft, two-bearing steam turbine-driven compressor, operating at 25,000 r.p.m., compresses steam from 375 psi to 600 psi at a rate of 18,000 pounds per hour.

For services requiring increased steam pressure, when boilers for generating such pressure are not available, centrifugal compressors can be used to provide the increased pressure where the volume is sufficient.

De Laval builds centrifugal blowers and compressors for handling air, steam and other gases for a range of volumes up to and above 100,000 c.f.m., and for pressures up to and above 100 pounds per square inch, the maximum economical pressure depending upon the inlet volume and density.

De Laval compressor and blower specialists will gladly confer with you on any gas handling problems you may have.

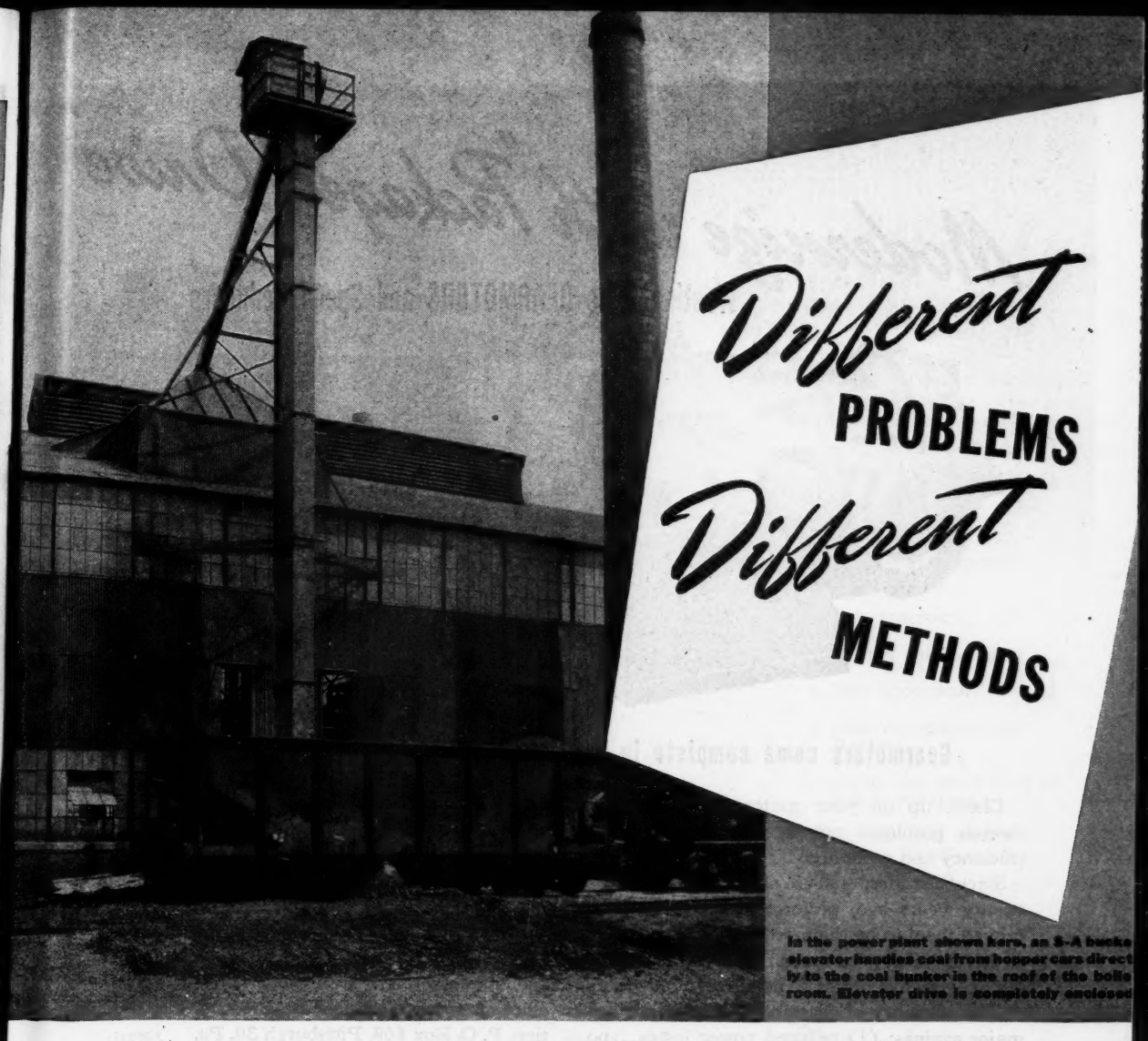
3828

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

DE LAVAL

STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

SALES OFFICES: ATLANTA • BOSTON • CHARLOTTE • CHICAGO • CLEVELAND • DENVER DETROIT • DULUTH • EDMONTON • GREAT FALLS • HAVANA • HELENA • HOUSTON KANSAS CITY • LOS ANGELES • MONTREAL NEW ORLEANS • NEW YORK • PHILADELPHIA PITTSBURGH • ROCHESTER • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE TORONTO • TULSA • VANCOUVER • WASHINGTON, D. C. • WINNIPEG



In the power plant shown here, an S-A bucke elevator handles coal from hopper cars direct ly to the coal bunker in the roof of the boile room. Elevator drive is completely enclosed

In This Case S-A *Bucket Elevator Is Key to Efficient Coal Handling . . .*

On the choice of the right type of handling equipment rests the success of your coal handling system for a long time to come. But unless each type is thoroughly investigated, there's a chance that the resulting installation will fall short of giving you maximum possible efficiency.

A Stephens-Adamson review of your problems is sure to cover the field. Because this company manufactures all basic conveyor and elevator types, its recommendations can be depended on to be free of any bias. The system which proves best suited to your special requirements may be a bucket elevator, like the one shown here. But you'll know that belt and enclosed types also receive full consideration.

You'll know, too, that whatever type is recommended, it will incorporate all that is best of Stephens-Adamson's 43 years experience in solving material handling problems to the users full satisfaction.

STEPHENS-ADAMSON MFG. CO.

515 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

MATERIAL HANDLING EQUIPMENT

Modernize with "Packaged Drive"

Westinghouse GEARMOTORS and Speed Reducers

Save Space
Save Installation Time
Reduce Maintenance
Increase Safety
Improve Appearance

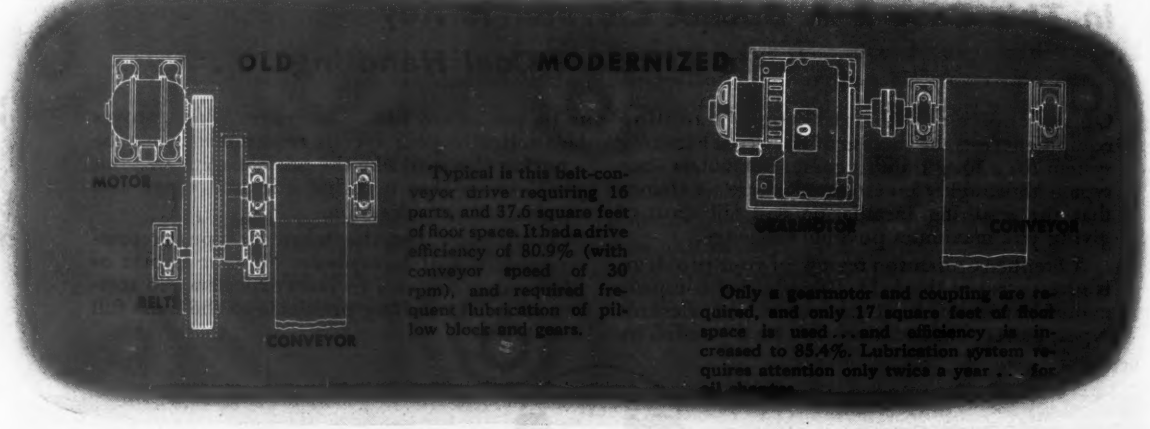
Gearmotors come complete in one "package"...ready for operation

Check up on your motor drives. Reconversion problems put a premium on their efficiency and economy.

Since the widespread use of gearmotors almost twenty years ago, performance records have proved them to be the most economical answer to drives which need speed reduction...and four out of every five drives do need speed reduction.

The efficiency of gearmotors stems from two major savings: (1) reduced power losses...no belts, ropes, and pulleys, etc.; (2) longer life and reduced outage time...maintenances seldom more than oil changes.

It's important, too, that your drives are engineered from one responsible source. When you come to Westinghouse you get undivided responsibility... the motor and gears are built by one manufacturer. Call your Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-07231



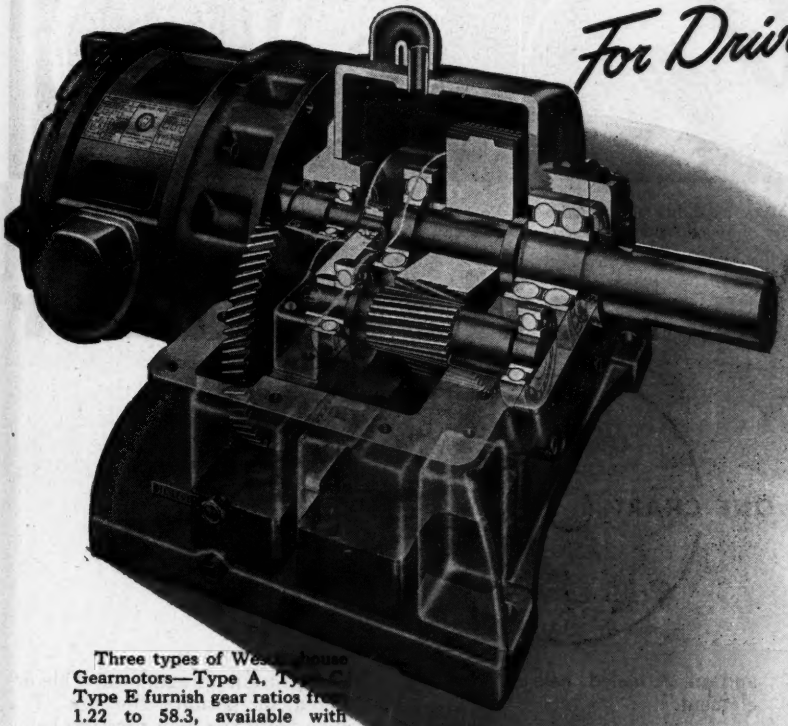
Typical is this belt-conveyor drive requiring 16 parts, and 37.6 square feet of floor space. It had a drive efficiency of 80.9% (with conveyor speed of 30 rpm), and required frequent lubrication of pillow blocks and gears.

Only a gearmotor and coupling are required, and only 17 square feet of floor space is used...and efficiency is increased to 85.4%. Lubrication system requires attention only twice a year... for all bearings.

Westinghouse

There is a Westinghouse speed reduction unit for most application needs

For Drives of 1 to 75 h p



Three types of Westinghouse Gearmotors—Type A, Type C, Type E furnish gear ratios from 1.22 to 58.3, available with single-phase, polyphase and direct-current motors.

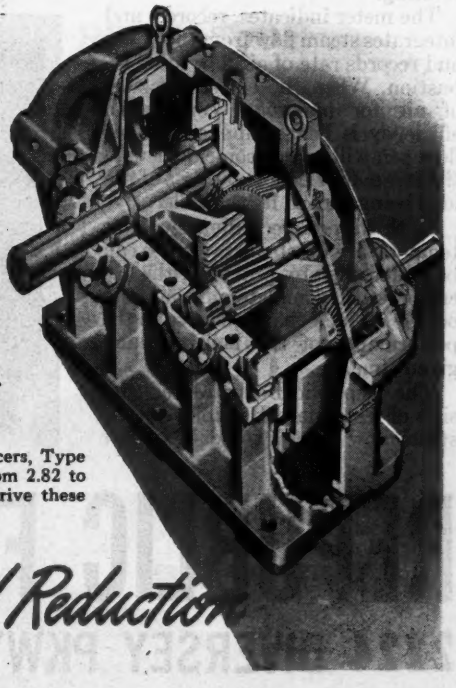
HERE ARE 9 GOOD REASONS WHY YOU SHOULD INSTALL WESTINGHOUSE GEARMOTORS:

1. FEWER PARTS TO WEAR.
2. BPT "TOUGH-HARD" GEARS AND PINIONS.
3. USE ALL WESTINGHOUSE MOTOR TYPES.
4. HIGH EFFICIENCY.
5. POSITIVE LUBRICATION.
6. EASY ACCESSIBILITY.
7. IMPROVED FOUNDATION STABILITY.
8. MOTOR AND GEARS BUILT BY ONE MANUFACTURER.
9. DESIGNED AND APPLIED TO A.G.M.A. STANDARDS.

For Drives up to 1000 h p

Here are seven good reasons why you should install Westinghouse Speed Reducers

- Antifriction bearings
- Simple, positive lubrication
- Heat-treated helical gearing
- Liberally proportioned gear cases assure alignment of rotating parts
- Low power loss for high efficiency
- Rugged case—split construction for easy accessibility
- Hob cutting assures high precision gears

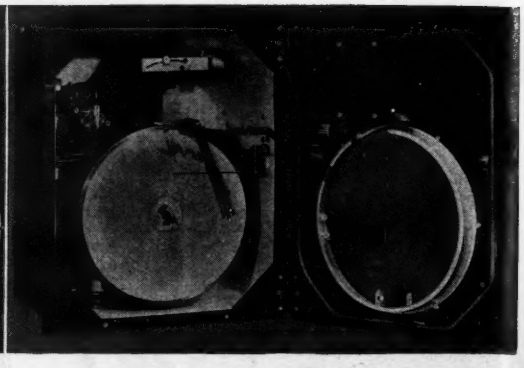


Two major types of Westinghouse Speed Reducers, Type SH and Type DH, offer speed reduction ratios from 2.82 to 70.5. Westinghouse also furnishes the motor to drive these units—for a complete installation.

4 out of 5 drives need Speed Reduction

Meter assembled as one unit on rack ready for calibration.

Meter assembly can be easily removed from the case.



Meter with door open showing accessibility of all adjustments and working parts.

Republic Boiler Meter

ON ONE CHART

STEAM FLOW
AIR FLOW
TEMPERATURE
OR PRESSURE

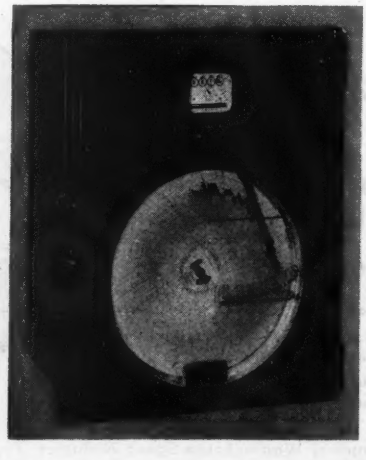
★ The new Republic Boiler Meter provides, in one instrument and on one chart, all the essential information concerning boiler performance regardless of the size or type of boiler, kind of fuel or method of firing.

The meter indicates, records, and integrates steam flow from the boiler and records rate of air flow for combustion. When the correct amount of air for maximum combustion efficiency is being supplied the air flow pen will record coincident with the steam flow pen, regardless of the load being carried by the boiler.

A third pen recording flue gas temperature (or steam pressure) can be added thereby providing the operator with complete information, on one 12-inch chart, relative to the performance of the boiler at any given time.

The Republic Boiler Meter consists of a standard Republic electric steam flow recorder and integrator and an oil sealed, bell type air flow element.

The air flow element consists of an oil sealed bell in a sealed chamber. The motion of the bell is transmitted through a diaphragm seal. This arrangement permits the use of a single bell—the high pressure being applied to the top of the bell and the low pressure under the bell. This arrangement also excludes air and dirt from the oil. The motion of the bell is transmitted to a cam system which extracts the square root, or when adjusted for a particular installation, compensates for chimney action and variable excess air requirements. The air flow pen is attached to the cam system with an adjustable linkage which permits changing the steam flow air flow ratio as conditions may require.



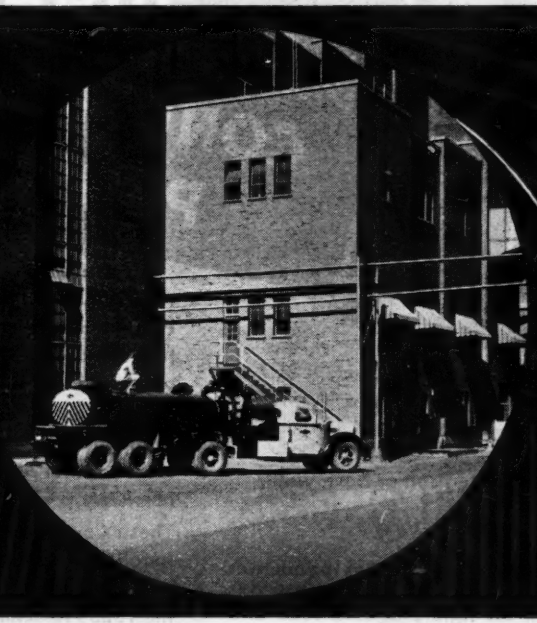
The entire operating mechanism is housed in a rugged steel case and can be easily removed as a single unit by merely loosening two anchor bolts and disconnecting the two air connections. The meter may be either wall mounted or flush mounted on a steel panel. *Write for Bulletin No. 420.*

REPUBLIC FLOW METERS CO.

2224 DIVERSEY PKWY. CHICAGO 47, ILLINOIS

DOWELL

CHEMICAL SCALE REMOVAL SERVICE



THOROUGHNESS . . . THE RESULT OF TECHNICAL ANALYSIS AND ENGINEERING

Dowell Chemical Scale Removal Service is used extensively in all kinds of plants in many states for the removal of water- and steam-deposited scales, sludges and oxides. The operators of these plants know from experience the many advantages, the thoroughness, safety and marked economies of the Dowell Methods.

Trained engineers analyze the power-stealing deposits. Types of metal and operating temperatures are determined. In a relatively few hours of down-time, without extensive dismantling of equipment, proper solvents are applied to dissolve, disintegrate and remove the deposits. The result is thorough cleanness and restored operating efficiency.

This complete service combines the chemical and engineering techniques of Dowell with the research and technical facilities of its parent organization, The Dow Chemical Company. Obtain further information from the nearest Dowell office.

DOWELL INCORPORATED

Tulsa 3, Oklahoma

Subsidiary of The Dow Chemical Company

New York • Philadelphia • Cleveland • Chicago • St. Louis • Houston
Kansas City • Wichita • Mt. Pleasant, Michigan • Salem, Illinois
Long Beach, California • Casper, Wyoming

Service from Long Beach and Casper provided by a Dowell associated company, International Cementers, Inc.

STOP THIS TUBE THINNING AND EROSION

Install JOHN CRANE CONDENSER TUBE PROTECTORS

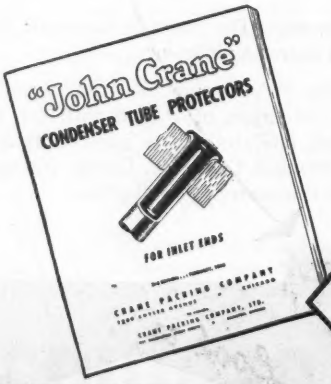
Design Features

- Resistant to contaminated salt or fresh water.
- Unaffected by temperatures to 275° F.
- Provides a Venturi entrance; reduces turbulence.
- Inner end is thin; fits tightly against tube and streamlines flow.
- Lasts for the life of the tube.
- Made for ⅝" and ¾" 16-BWG, or ⅝", ¾", ⅞" and 1" 18-BWG tubes.

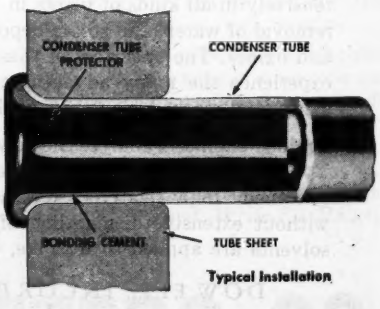
Provide an armor for the inlet ends of condenser tubes and you eliminate the most common source of tube failure.

John Crane Condenser Tube Protectors answer the problem of tube end thinning. They act as a protective armor at the entrance section of the tube—*absolutely prevent all erosion and abrasion.*

These Condenser Tube Protectors are molded of a tough, wear-resistant thermo-setting plastic. Installation is easy on old or new tubes; simply slip the Tube Protector into place, in most cases without removal of waterbox head.

Service Tests on many types of Marine and Stationary Heat Exchangers prove that John Crane Condenser Tube Protectors greatly lengthen tube life, saving critical metal.

Power and Marine Engineers: Get the complete facts on the John Crane Condenser Tube Protector.

SEND FOR THIS BULLETIN



Typical Installation

CRANE PACKING COMPANY

1812 CUYLER AVENUE • CHICAGO 13, ILLINOIS

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

Users find many ways to save with Standard

Using costly lubricants where ordinary lubricants are good enough is like pouring money down a rat hole.

Expensive lubricants are protected against waste.

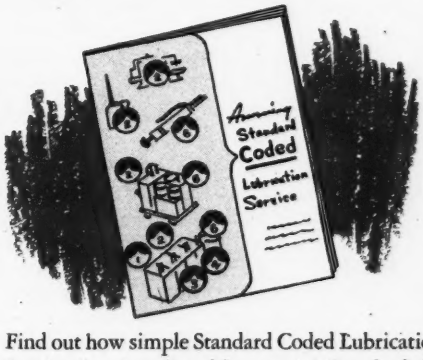
The *right use* of lubricants is of as much interest to us, the supplier, as it is to you, the user. That is why this simple method of getting the *right* lubricant in all the *right* places—Standard Coded Lubrication Service—is offered to all companies in the Middle West served by Standard Oil Company (Indiana).

1 CODED 2 LUBRICATION

A central state plant superintendent says, "Your Coded Lubrication Service solved one of my biggest headaches. We use many types of lubricants. Some are rather special and costly. With your system I am more certain that these special products are used where they should be and *not* used by mistake where ordinary lubricants are good enough."

This plant man gets a two-way saving. Expensive equipment is protected against breakdowns caused by the use of the wrong lubricant.

Send for this booklet



Find out how simple Standard Coded Lubrication Service is to install and keep up. A Standard Oil Lubrication Engineer will be glad to discuss its application with those in charge of lubrication in *your* plant. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for a copy of the booklet or the Lubrication Engineer nearest you.

Buy more War Bonds

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . . LUBRICATION ENGINEERING . . .

How to cut lubricant leakage and throw-off . . . safely!!

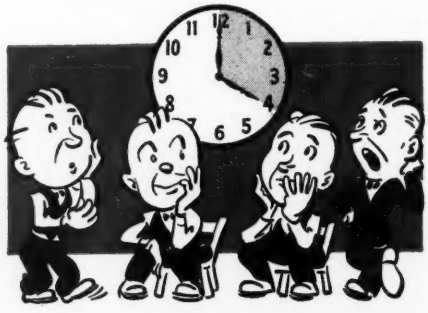
THE PROBLEM of oil leakage from bearings or gear cases, or oil throw-off from rapidly moving parts such as chains or open gears, recurs regularly in practically every plant. The cure is sometimes very simple, such as installing new seals on bearings or gear cases, or using a heavier grade of oil.

But the problem can be complicated, for example, when parts are hard to get, when shut downs to make repairs on machines are out of the question, or where heavier grades of lubricants do not give proper lubrication. In these cases, Stanodrip has solved the problem for many manufacturers.

Excessively heavy lubricants, while they may stop leakage, usually result in overheating, particularly on high speed bearings. Or they may not circulate in gear cases, thus providing little or no lubrication. Stanodrip stops leakage where a regular oil of approximately the same grade will not. Stanodrip contains special additives which resist the tendency to drip or creep, but do not impair its lubricating quality. Let a Standard Oil Lubrication Engineer help you apply Stanodrip to eliminate unsightly, oil consuming, lubricating jobs in your plant. He will be glad to make a test of Stanodrip with you.

Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois, for the Engineer nearest you.

How Stanodrip saves lubricant, maintenance, and production time



Saves 4 hours time of 4 operators each month. In a St. Louis plant every clutch failure on a bomb-nosing machine tied up the machine for four hours, losing the time of four operators and costing $80 for replacements. In spite of the fact that a number of lubricants were tried, clutch faces had to be replaced at least twice a month on each of the three machines. It was about decided that there was no way out of the predicament. Then a Standard Lubrication Engineer suggested a test of Stanodrip because of its ability to stay on the plates and reduce wear. As proof that it did, there have been no clutch failures on the three machines in the first two months' operation.

Saves half the lubricant and all of the cutting oil. Dilution of the cutting oil by the bearing lubricant on a battery of old screw machines in a Michigan plant made it necessary to change many batches of cutting oil long before they were used up. When the straight mineral oil that was used on the bearings was replaced by Stanodrip, lubricant consumption was cut in half and cutting oil dilution practically eliminated.

Stanodrip

Buy more War Bonds

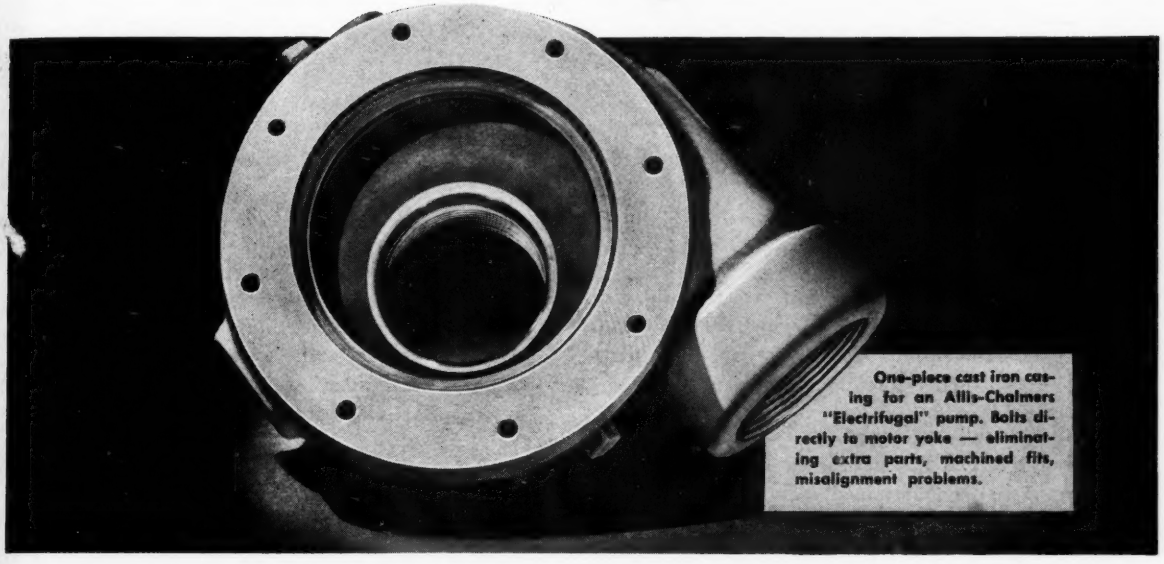
STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

★ LUBRICATION ENGINEERING

[PUMP TIPS FROM ALLIS-CHALMERS—ONE IN A SERIES]

How to make CASINGS Last Longer . . .



One-piece cast iron casing for an Allis-Chalmers "Electrifugal" pump. Bolts directly to motor yoke — eliminating extra parts, machined fits, misalignment problems.

ABRASION AND CHEMICAL REACTION are the major causes of casing wear. For if liquid is gritty, or contains foreign matter; or casing is not constructed of the right materials for the pumping service required — casing life is materially shortened. A minor cause of direct casing wear is misalignment.

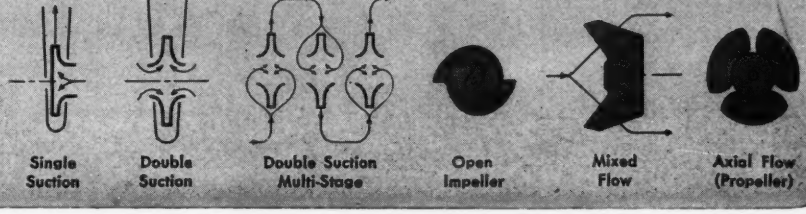
Original engineering of a pump can help prevent this wear. For example, Allis-Chalmers "Electrifugal" pump minimizes trouble from these sources in two ways: 1 — casings can be supplied in iron, bronze, stainless steel or other materials — depending upon type of service. 2 — It is a *unit-design* pump. Both impeller and motor are mounted on *one* shaft and in *one* frame. This means fewer parts, fewer fits — no chance for misalignment.

However, regardless of pump design, scheduled maintenance is still necessary if you expect to get longest wear from your casings. Some ways to do it . . .

- Check all piping supports regularly to see that they're effectively supporting the load.
- Every 6 months check piping itself to see whether it has shifted in any manner. Disconnect suction and discharge piping to see if it springs in any direction. Check the alignment of pump and motor — shimming up units as required.
- Once a year clean and inspect casing for wear, deposits or pitting. Make necessary repairs.
- If foreign matter is being sucked into pump, wearing casing unduly, provide the intake end of suction piping with a suitable screen.
- Send for your *free* copy of "Handbook for Wartime Care of Centrifugal Pumps". This valuable booklet applies to *all makes* of pumps; contains *no* advertising. ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS. A 1755

ALLIS-CHALMERS PUMPS

Allis-Chalmers builds all types and variations of pumps shown at right. Capacities from 10 to 150,000 gpm—heads to 2500 lbs.



WHY BETZ BOILER WATER CONTROL CALLS FOR DAILY PLANT TESTS

Daily plant control is of major importance to efficient boiler water conditioning. Without it, because of varying boiler load and feedwater characteristics, costly over-treatment or dangerous under-treatment will result.

In rendering a complete and detailed supervisory service BETZ determines the boiler water testing limits to be maintained and furnishes a control chart especially prepared for each individual plant. This chart shows the plant engineer exactly what to do to maintain the most desirable softener and boiler water chemical balances. The daily chemical control tests performed at the plant enable the operator to hold the boiler water between the prescribed control limits at all times.

On the facing page there is shown a Boiler Water Control Report form on which the results of the daily plant tests are entered for the plant record. Copies of these reports are mailed to our laboratories where they are carefully reviewed and a detailed report is submitted to the plant, calling attention to any deficiencies revealed by the test record.

This dual system of daily plant testing and Betz laboratory control is one of the most important factors in the complete and individualized supervisory service for boiler water conditioning offered by the Betz organization. It is an assurance of continuously efficient boiler water treatment.

W. H. & L. D. BETZ

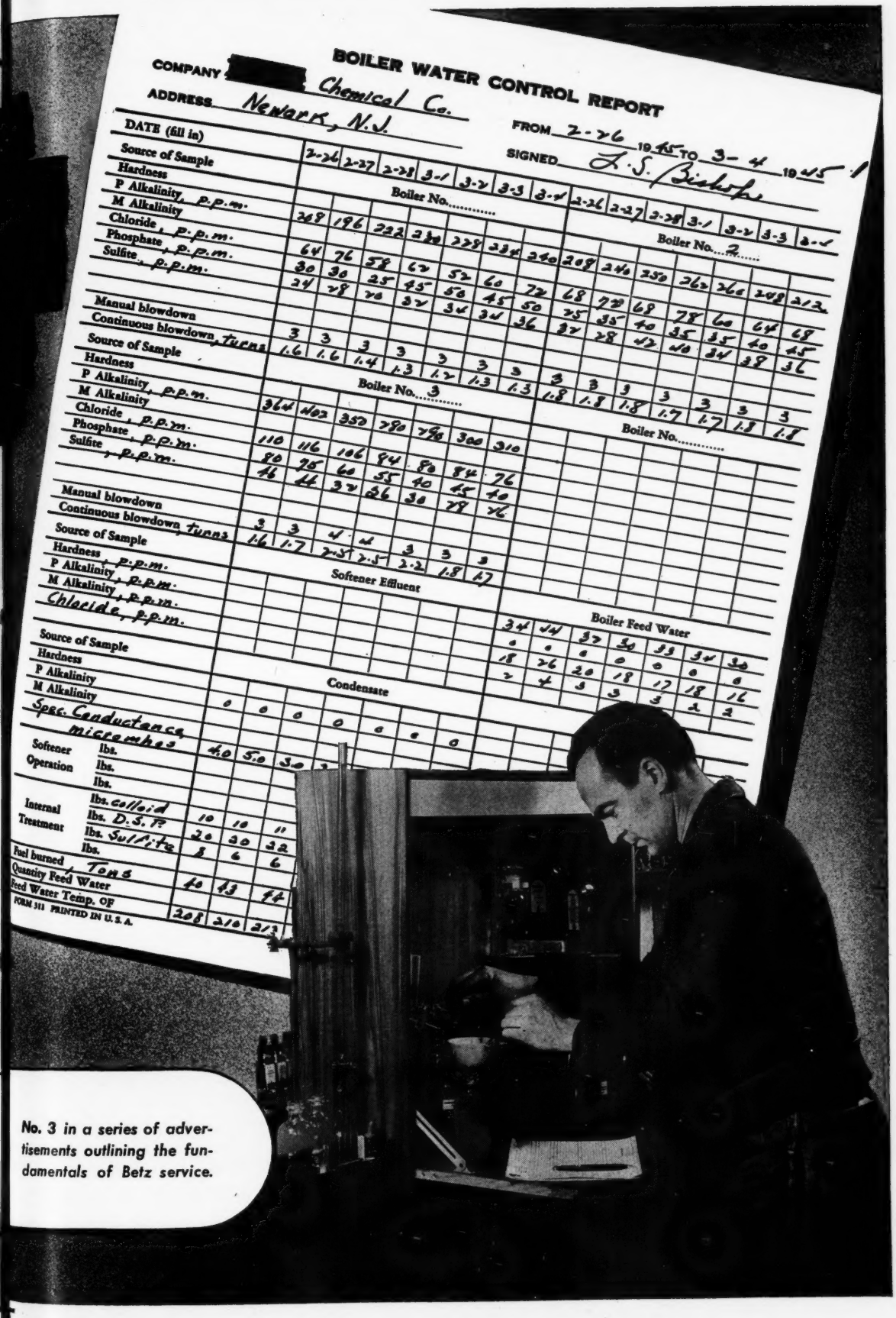
Gillingham & Worth Sts., Philadelphia 24, Pennsylvania

THE 6 FUNDAMENTALS OF BETZ BOILER WATER CONDITIONING SERVICE

1. Complete plant investigation and report.
2. Establishment of plant control.
3. **Daily plant control tests.**
4. Detailed review of plant tests and report.
5. Supplementary complete laboratory analyses.
6. Periodic "check-up" visits.

BETZ

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS



BOILER WATER CONTROL REPORT

COMPANY [redacted] Chemical Co.
ADDRESS Newark, N.J.
FROM 2-26 1945 TO 3-4 1945
SIGNED L. S. Bishop

DATE (fill in)	2-26	2-27	2-28	3-1	3-2	3-3	3-4	2-26	2-27	2-28	3-1	3-2	3-3	3-4
Source of Sample	Boiler No.							Boiler No. 2						
Hardness														
P Alkalinity, p.p.m.														
M Alkalinity	208	196	222	230	228	234	240	208	246	250	262	266	208	212
Chloride, p.p.m.														
Phosphate, p.p.m.	64	76	58	62	52	60	72	68	78	68	78	60	64	68
Sulfite, p.p.m.	30	30	25	45	50	45	50	35	35	40	35	35	40	45
	24	28	20	32	34	34	36	32	28	32	40	34	38	36
Manual blowdown														
Continuous blowdown, turns	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Source of Sample	1.6	1.6	1.4	1.3	1.2	1.3	1.3	1.8	1.8	1.8	1.7	1.7	1.8	1.8
Hardness	Boiler No. 3							Boiler No.						
P Alkalinity, p.p.m.														
M Alkalinity	364	402	350	280	296	300	310							
Chloride, p.p.m.														
Phosphate, p.p.m.	110	116	106	94	80	84	76							
Sulfite, p.p.m.	80	76	60	55	40	45	40							
	46	44	32	26	30	28	26							
Manual blowdown														
Continuous blowdown, turns	3	3	4	4	3	3	3							
Source of Sample	1.6	1.7	2.5	2.5	2.2	1.8	1.7							
Hardness, p.p.m.	Softener Effluent							Boiler Feed Water						
P Alkalinity, p.p.m.														
M Alkalinity, p.p.m.														
Chloride, p.p.m.								34	44	32	30	33	34	30
Source of Sample	Condensate							0	0	0	0	0	0	0
Hardness								18	26	20	18	17	18	16
P Alkalinity								2	4	3	3	3	2	2
M Alkalinity	0	0	0	0	0	0	0							
Spec. Conductance, micromhos														
Softener Operation lbs.	4.0	5.0	3.0											
lbs.														
lbs.														
Internal Treatment lbs. Colloid														
lbs. D.S.P.	10	10	11											
lbs. Sulfite	20	20	22											
lbs.	8	6	6											
Fuel burned, Tons														
Quantity Feed Water	40	43	44											
Feed Water Temp. °F														
	208	210	212											

FORM 311 PRINTED IN U.S.A.

No. 3 in a series of advertisements outlining the fundamentals of Betz service.

A routine test

that could wreck the plant

made safe by HAGAN CONTROL

THE BOILER PLANT of one of the country's largest steel plants consists of four 2500 H.P. boilers operating at 450 pound pressure. Primary fuel is blast furnace gas, with powdered coal make-up when gas supplies are inadequate.

Continued feeding in case induced-draft fan motors were out of operation might easily wreck the plant—but once a month, for nine years, the plant engineers *deliberately created this emergency.* They provided a special test switch that opened the circuit to these motors and set up exactly the same situation that would result in case of power failure.

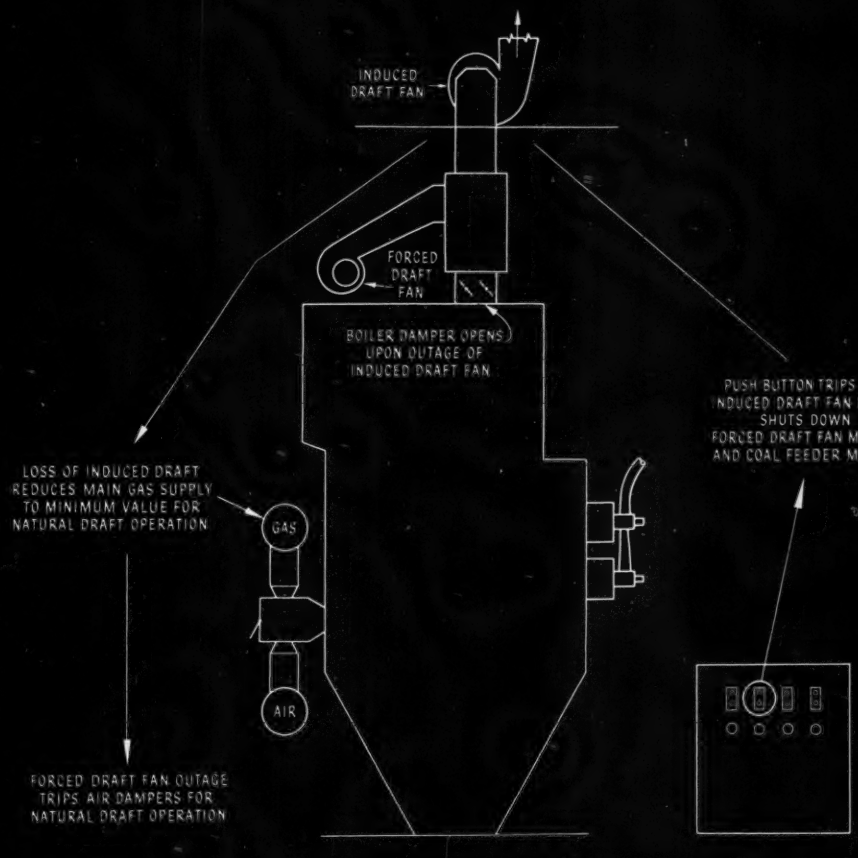
With Hagan Control on the job, here is what happened:

As soon as the induced-draft fans were cut off, the forced-draft fans shut down, the boiler damper opened wide, the feeder motors stopped, air inlets from atmosphere to the gas burners were opened, and the gas control valve closed to a point where it passed only the amount of gas which could be burned with natural draft.

In a matter of seconds, the boiler was automatically and safely adjusted to a reduced rating, with natural draft, until electric power was restored.

This plant has completed 13 years of steady operation, with Hagan Automatic Combustion Control maintaining constant steam pressure in spite of extreme load swings and frequent transitions from one type of fuel to the other.

This great record of dependability is made possible by the Hagan principle that *control and recording are separate functions.* Hagan Control continues to function reliably at ranges well below those at which meter accuracy is guaranteed. Every instrument on the panel can be out of service without affecting the precision and reliability of Hagan Automatic Combustion Control.


INDUCED DRAFT FAN
FORCED DRAFT FAN
BOILER DAMPER OPENS UPON OUTAGE OF INDUCED DRAFT FAN
PUSH BUTTON TRIPS OUT INDUCED DRAFT FAN MOTOR, SHUTS DOWN FORCED DRAFT FAN MOTORS AND COAL FEEDER MOTORS
LOSS OF INDUCED DRAFT REDUCES MAIN GAS SUPPLY TO MINIMUM VALUE FOR NATURAL DRAFT OPERATION
GAS
AIR
FORCED DRAFT FAN OUTAGE TRIPS AIR DAMPERS FOR NATURAL DRAFT OPERATION

Write for full information

HAGAN CORPORATION • HAGAN BUILDING • PITTSBURGH 30, PA.

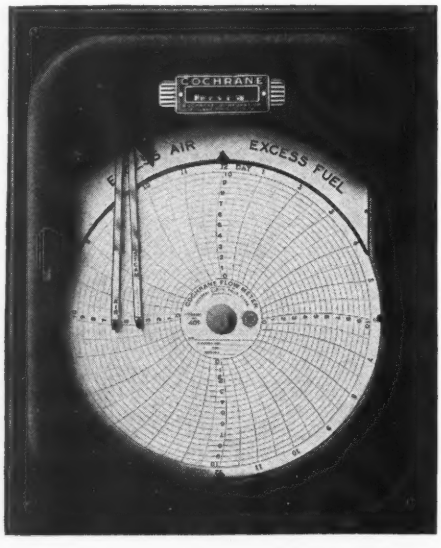
HAGAN HALL BUROMIN CALGON

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

2 remarkable Meters

from the COCHRANE line



THESE four essential qualities are inherent in every Cochrane Boiler Meter.

(A) An accurate and reliable Steam Flow Meter. Cochrane's tested Galvanometer Null principle insures this accuracy.

(B) An accurate and reliable Air Flow Meter. The slack diaphragm unit measures the difference in air flow, acting as a pilot, while an auxiliary motor drives the mechanism, securing hysteresis-free accuracy.

(C) A convenient cam adjustment covering the entire range of the air flow pen. An adjustable cam is mounted on the motor shaft on which rides the arm positioning the recording pen. A pointer and scale are provided for convenience in calibration.

(D) An easily observed indication of difference in reading air flow above or below steam flow. A red indicating pointer, easily seen across the boiler room, shows this ratio, amplifying the pen difference three times.

1. Steam Flow-Air Flow BOILER *Ratio* METER

2. High Torque MECHANICAL FLOW METER

NULL BALANCE

THIS is one of the oldest and most reliable flow meters ever built. Like the jeweler's scale its accuracy is based on the beam balance. Difference in rate of flow shifts the mercury from one side of the U-tube to the other, tilting the balance on a pair of knife-edges and actuating the pen arm and pointer. A scientifically shaped cam keeps the balance proportional to the rate of flow.

Write for complete information on this remarkable flow meter, thousands of which are in service in all parts of the world.

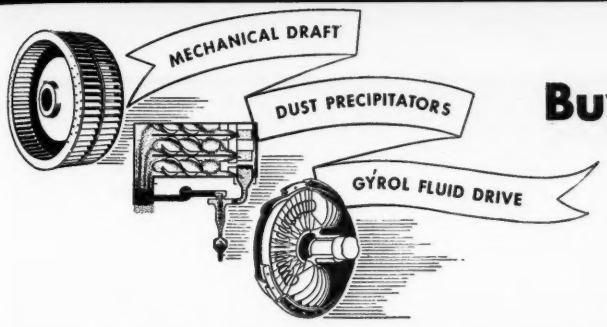
COCHRANE CORPORATION
A DIVISION OF AMERICAN ENGINEERING COMPANY

ARMY E NAVY

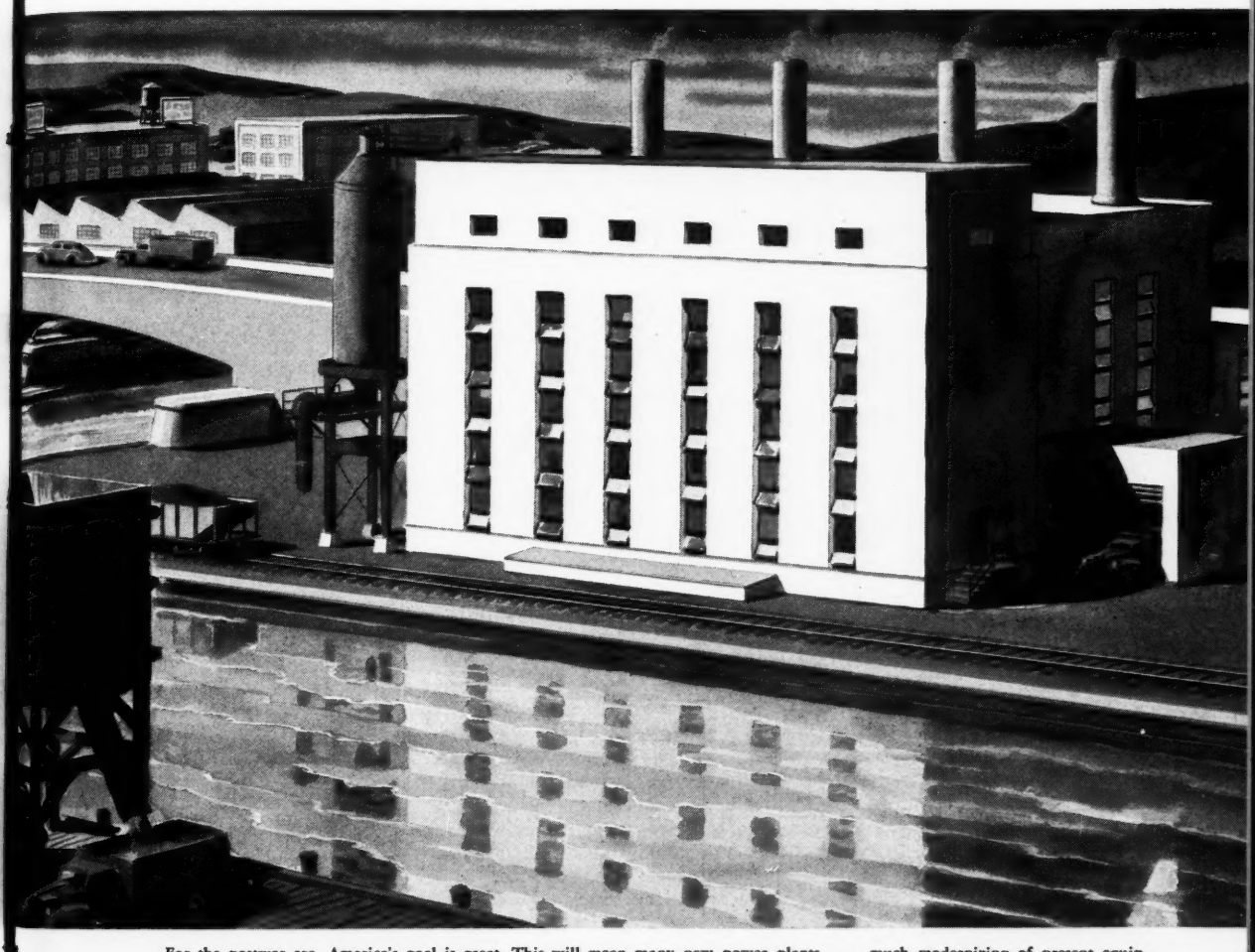
3123 N. 17th ST., PHILADELPHIA 32, PA.

COCHRANE

SOFTENERS · DEAERATING SOFTENERS · DEAERATORS · METERS · STEAM SPECIALTIES



Buying all 3 from A. B. C. Centralizes Responsibility



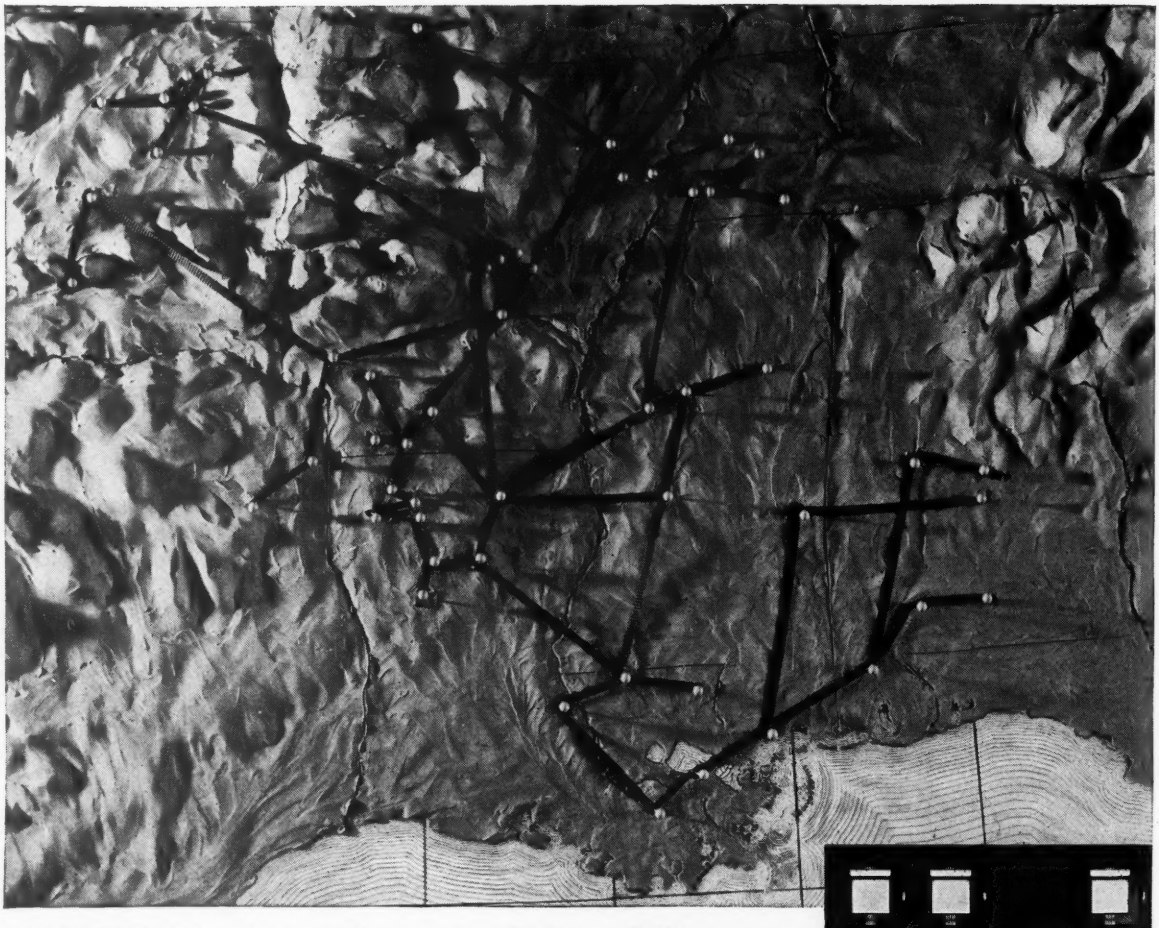
For the postwar era, America's goal is great. This will mean many new power plants . . . much modernizing of present equipment. Buying all 3 — Mechanical Draft Equipment, Dust Precipitators, and Gyrol Fluid Drive — from American Blower will centralize responsibility, cut red tape and give you one source of reliable technical information. Contact the nearest American Blower Office today.

OUR COMPLETE FACILITIES for testing and analyzing dusts of every description are always available to you and your engineers. We have one of the largest and finest Dust Testing Laboratories in the industry, with a collection of dust samples on more than 4,100 distinctly different materials. Arrange now to have your engineers run tests in our laboratories. No dust problem is too large or too small for our careful attention. There is no charge for analyzing and testing dust, but there is a big benefit to be derived from this procedure if you do it before you buy Dust Precipitators or Collectors of any make or type. Phone or write American Blower today.

AMERICAN BLOWER

AMERICAN BLOWER CORPORATION, DETROIT, MICH.
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.

Division of American Radiator & Standard Sanitary corporation



ALMNO Stations Borrow & Lend Power With Help of this L&N Panel

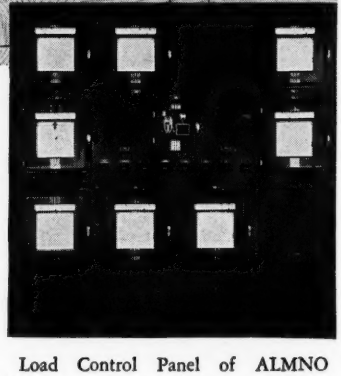
The Control Panel at the right makes it easier for the ALMNO power pool's member Companies to carry on the continuous borrow-lend transactions which are the pool's reason for existing.

Installed in the ALMNO load-dispatching office, the Panel has two functions: (1) To keep accurate, instantaneous record of the borrowing-lending of power over each of the tie lines. (2) To maintain the load on any tie or ties by operating the generators in distant stations. In performing this control, the Panel does not merely signal the station; it operates the motor-governor contacts on the individual generator or generators. And any type of control which the operator could thus maintain can be maintained (with greater accuracy) by the Panel.

Only about one-tenth as many telephone calls are necessary, between dispatcher and station, as would be needed if this Panel were not used. This saving in time is of course a great help in the accurate following of load schedules.

L&N Load-Frequency equipment is described in Technical Publication N-56-161 (1), sent on request.

Jrl Ad N-56-161(6)



Load Control Panel of ALMNO (Arkansas - Louisiana - Mississippi - New Orleans) power pool's system. Micromax Recorders show load on the tie lines at Ashdown, Markham's Ferry, Memphis and Gulfport, and on any combination of ties. A sixth Micromax records system frequency. Two more record generations at Carpenter and Sterlington Stations, and the remaining instrument operates these stations to maintain load on any tie or ties.

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

depends on me!

A Slogan For Every American

This RUST Prevention Program may save you $10,000 too!

Manufacturer salvages 12,000 Ballistic Dies . . . protects further production with ANTI-CORRODE

A complete plant rust-prevention program is certain to insure operating economy and accelerate production. Backed by a complete line of tested Anti-Corrodes for every industry, Cities Service engineers are prepared to study *your* rust problems and recommend a specific plan to eliminate them.

Here's an Example . . .

A Bloomfield, N. J., manufacturer of ballistic dies had a costly problem. After partial completion, his dies were boxed, then shipped to another plant for final treatment. The dies invariably rusted so badly during return transit that they actually would stick together. 12,000 in this condition had accumulated in the plant, representing an investment *in labor alone* of eight to ten thousand dollars.

Cities Service engineers were called in. They supplied a product to clean the defective dies quickly . . . specified a special grade of Cities Service Anti-Corrode to protect them in storage. Three months later the dies were accepted for completion by the final processor. All dies thereafter were immediately dipped in this Anti-Corrode. The rust problem was licked.

Performance records such as this are being chalked up every day by Cities Service engineers in every industry — Mining, Textile, Metal-Working, Construction and others.

See what Cities Service can do for you. Call in our engineers now. Contact your local Cities Service office or mail this coupon.

ANNUAL RUST TOLL CONSERVATIVELY ESTIMATED AT $100,000,000 . . . All metals when exposed to the elements have an inherent tendency to revert to one or another of the forms in which they were originally found in the earth. Iron rust is the most common example of this action. Best safeguard for *your* equipment is a carefully planned and followed Rust-Prevention program.

ANTI-CORRODE safeguard for Industry

CITIES SERVICE OILS — ONCE-ALWAYS — YOUR SYMBOL OF SERVICE

Cities Service Oil Company
Room 329, 70 Pine Street, New York 5, N. Y.

Gentlemen: Please have your engineers discuss with me a program of rust-prevention for our plant. (No obligation, of course.)

Name.....

Title.....Company.....

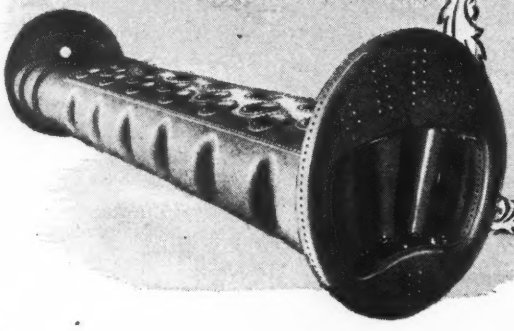
Address.....

City.....State.....

Since 1878...

Steam Generating Equipment

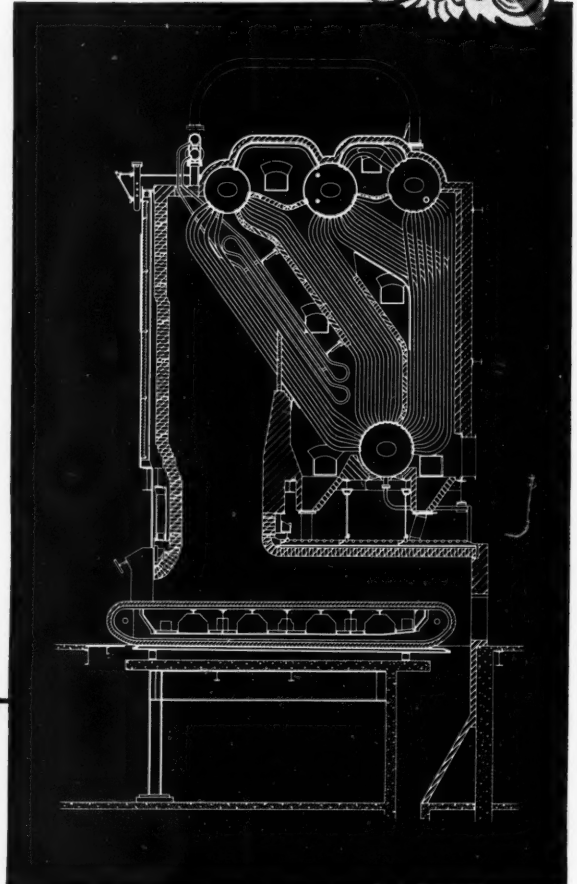
by EDGE MOOR



How many power engineers can identify the illustration at the left? It is the internal flue of an "Improved Galloway Boiler," an outstanding type in its day. Edge Moor began building Galloway boilers in 1878—and have been engaged in designing, developing and building steam generating equipment ever since.

Back of every Edge Moor installation of today there is the wealth of experience acquired through 67 years of boiler building—a cumulation of skills, methods and knowledge that enables Edge Moor to build boilers as outstanding in performance as were the Galloways in the days of the previous century.

Edge Moor boilers are designed for any required capacity and up to 900 lbs. drum pressure. Complete steam generating units, auxiliary equipment and installation service are available including boilers, superheaters, water walls, economizers and air preheaters. The combination of Edge Moor engineering experience and manufacturing control assures the ultimate in power plant performance.



Edge Moor bent tube boiler with pendant interbank superheater and travelling grate stoker. Capacity 47,500 lbs. steam per hour; Drum Pressure, 275 psi; Degrees of Superheat, 180° F.; Final Steam Temperature, 585° F.

STEAM GENERATING EQUIPMENT

EDGE MOOR
IRON WORKS, INC.

BRANCH OFFICES: NEW YORK 20, N. Y.: 30 ROCKEFELLER PLAZA
CHICAGO 2, ILL.: ONE NORTH LA SALLE STREET

MAIN OFFICE AND WORKS: EDGE MOOR, DELAWARE

Ernst WATER COLUMN & GAGE CO.

Tel. Livingston 6-1400

250 SOUTH LIVINGSTON AVENUE

LIVINGSTON, NEW JERSEY

Manufacturers for More Than 40 Years

Specify:

Fig. 1
High and Low Alarm Column Equipped with Split - Gland Type Adjustable Inclined Water Gages.

Ernst

SAFETY

HIGH AND LOW ALARM

WATER COLUMNS

FOR

BETTER VISIBILITY

UP TO

900 PSI

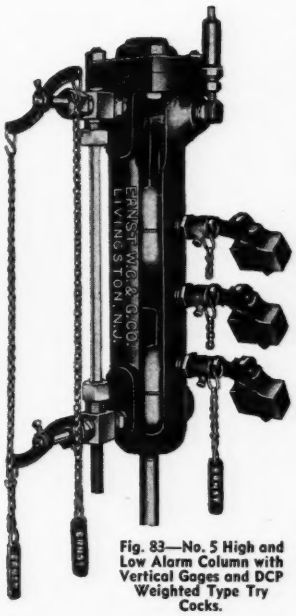


Fig. 83—No. 5 High and Low Alarm Column with Vertical Gages and DCP Weighted Type Try Cocks.

Fig. 9
Better-C Guard Shown attached to Ernst Vertical Forged Steel Gage Valves, these Valves can also be supplied in all Iron and Bronze.

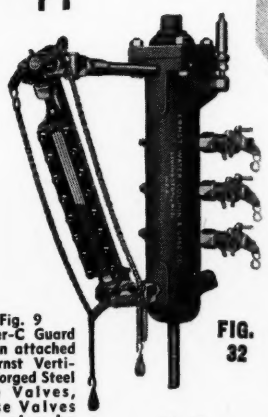


FIG. 32

Fig. 32
Column Equipped with Prismatic Reflex Inclined Water Gage—Steam shows White, Water shows Black.

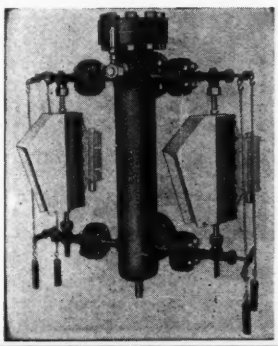


Fig. 85
High and Low Alarm Column Equipped with Two Gages and C-Clear Thru Inserts including direct vision Hoods.

Fig. 13
Leakless Super Try Cocks, Bronze and Forged Steel Construction.

Fig. 16

Sight Glasses for All Types Oil Cups and Lubricators

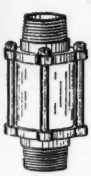


Fig. 17

Sight Flow Indicators for Insertion into Pipe Lines—All Sizes—

Fig. 12 Fig. 23 X Strong Fig. 14 Red Line

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GAGE GLASSES, ROUND AND FLAT TYPE, MICA SHIELDS, RUBBER GASKETS, NEOPRENE GASKETS, CORK WASHERS, SUPPLIED IN ALL SIZES, AND FOR ALL PRESSURES AND TEMPERATURES.

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Fig. 22—Standard Pattern Gaskets, High-Pressure, Non-hardening and Non-softening Series 750

Fig. 21—Red Lip-Mold Pattern Expansion Type Gasket.

Cork Washer.

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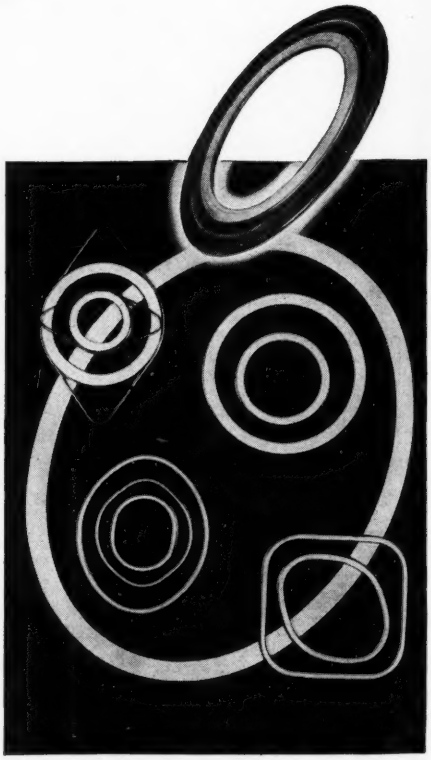

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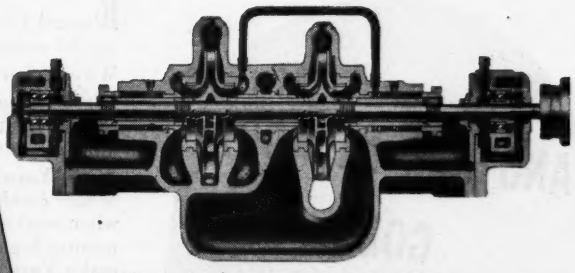
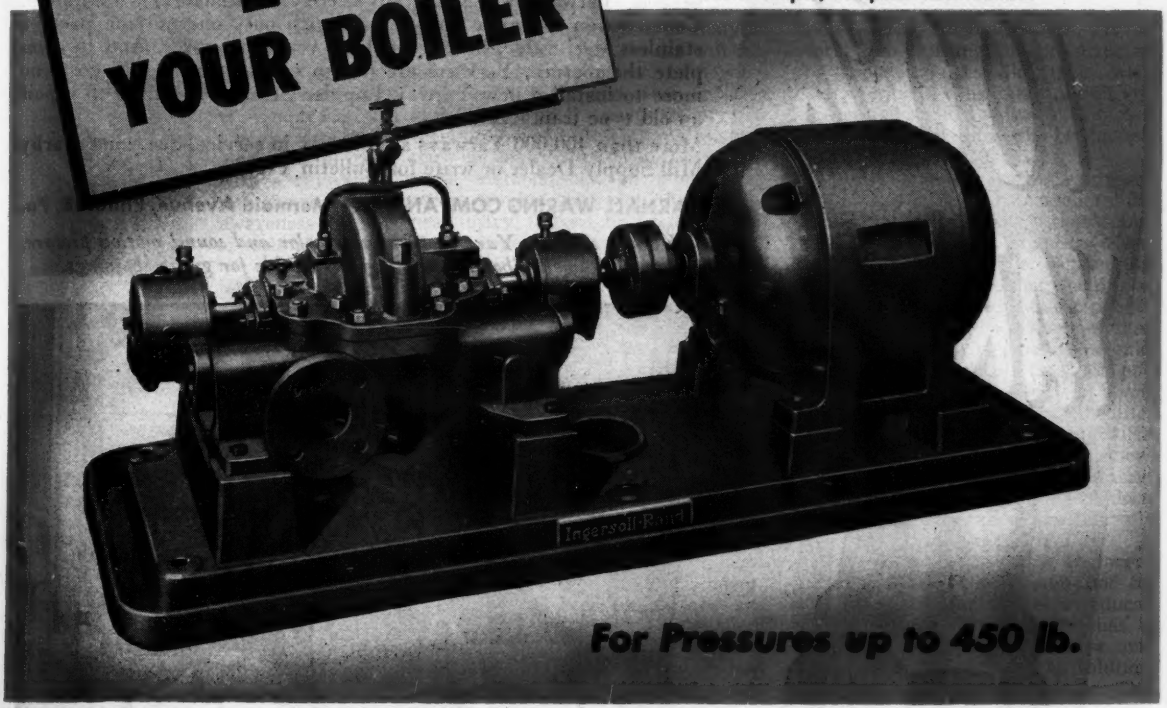


Note: simple, compact construction.



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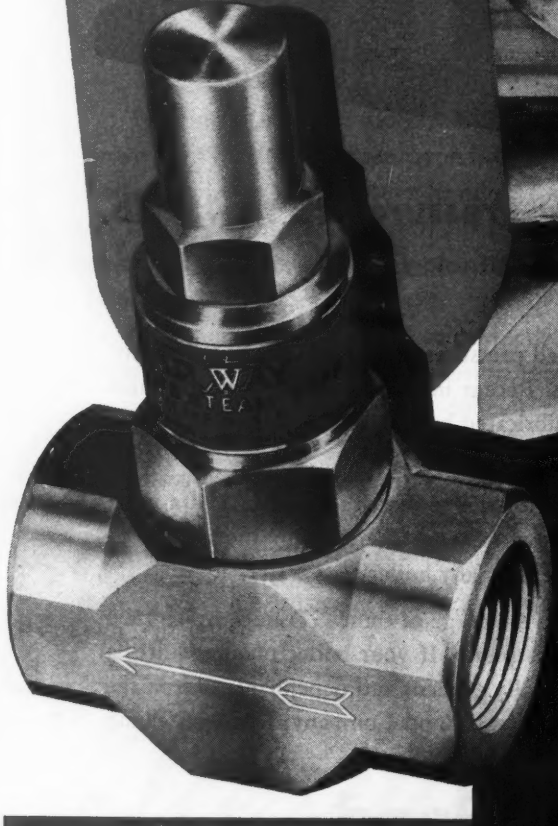

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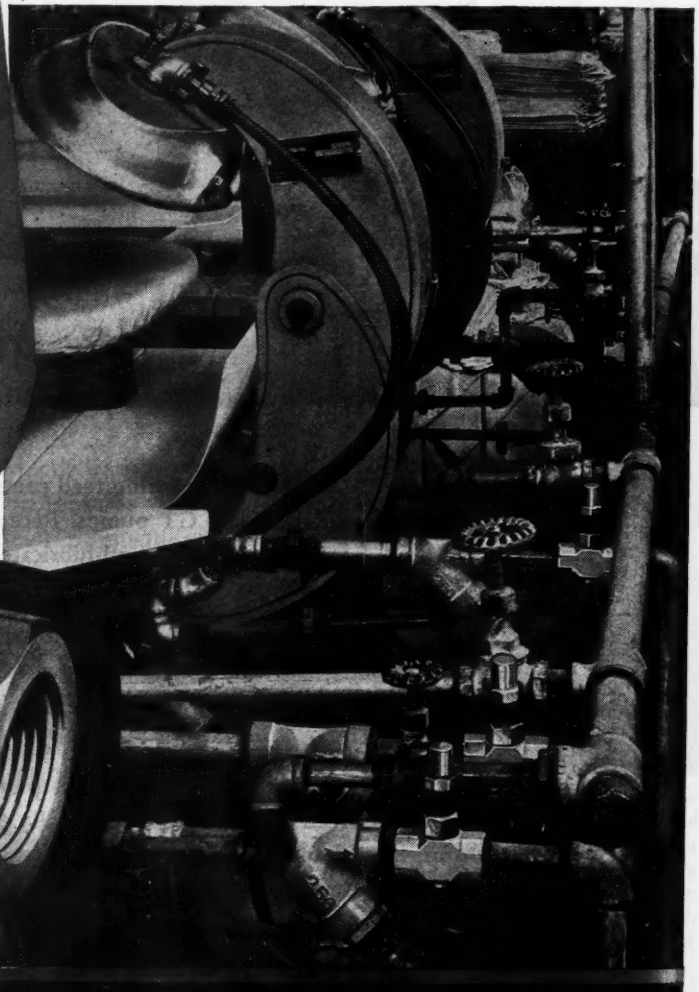


YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Phoenix—A Challenge

By W. L. EVERITT

ENGINEERING education is now being burned by the fires of a technological war. Will ti arise from the ashes, like the Phoenix of old with a rejuvenation shown by its awareness of its opportunities, and the vigor to attack and solve its problems? Or will it simply continue on the path laid out by the old curricula and methods after a temporary recess? The choice is plain, and must be made by engineers and educators now, if a "Phoenix" is to be ready when the war is over.

Most of the upper-class engineering students in school at the time of Pearl Harbor were allowed to complete their college courses. After the war, a new crop of freshmen will enter and be carried forward. Now is the time for the engineering design of curricula in the several branches of professional engineering. In fact, if this opportunity is passed by we may not in our lifetime have another.

Of late, there has been a particular tendency to imply that scientific and engineering education are one and the same thing. If this be so, then the engineering colleges have no justification for their existence and their duties should be absorbed by the appropriate basic science departments. The writer believes there is a definite and important difference, and furthermore that this difference has not been taken into account in the *evolutionary* development of engineering curricula.

The most fundamental difference between Science and Engineering is the difference between *Analysis* and *Synthesis*, Science is interested primarily in learning what effects follow causes, in learning why and how nature, both physical and biological, behaves as it does, and in analyzing everything and finding out what to expect under a given set of conditions. Engineering, on the other hand, attempts something quite different. It is interested in assembling a combination of men and materials to produce a desired result or a reasonable facsimile thereof. This is the process of synthesis, of putting things together to accomplish a definite end.

The processes of synthesis can be accomplished only after a thorough grounding in the processes of analysis. One must know what results will follow from definite causes, both when they occur singly and when in combinations. But the methods of synthesis go beyond those of analysis and must be learned as such. Certain of these methods can be taught, but others involve judgment, the willingness to try, to recognize failures, and to try repeatedly, and some involve intuition.

In our engineering curricula, we have taught the student almost exclusively the methods of analysis and very little of the methods of synthesis. He attends classes and laboratories and learns what happens when certain forces and materials are brought together. Very seldom does he have the opportunity to assemble, either on paper or in physical being, from out of all the world of nature at his disposal, a combination to produce a desired result. Engineering curricula have omitted instruction in "Engineering." As a result of this, our students go out as graduates, obtain jobs, and then ask "Why wasn't I told about this thing called engineering before?" We have taught the engineer how his tools are put together, but generally we have not shown him how to use them.

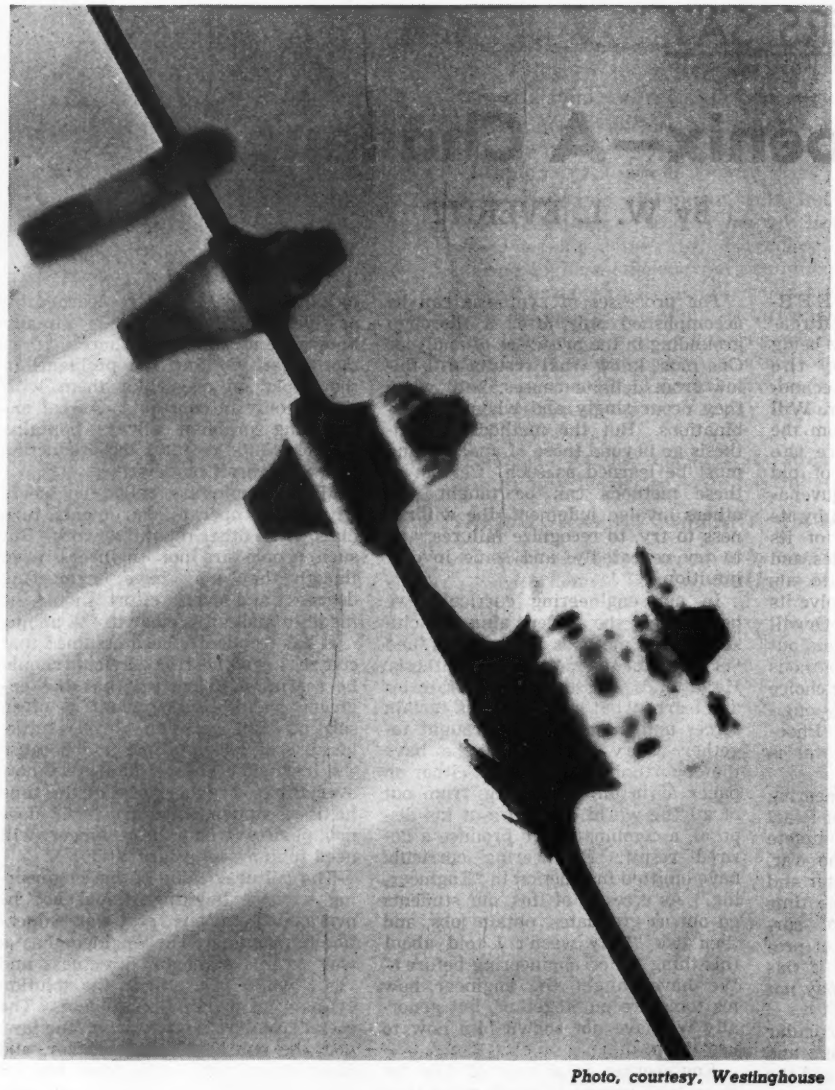
Engineering is a way of life for those who pursue it, much more than a way of making a living. An engineer cannot be made by academic procedures alone, but these procedures should point the way from the beginning. Clear thinking should be an essential in an engineering education and yet we have not been clear even in explaining to him what engineering is. Engineering is a dynamic force, it requires *doing* in order to exist, and it cannot be learned by passively studying what is already known, and stopping there. It is more than working the problems in the book, or ones like them with change only in constants. A real engineering problem always contains new elements, requires the production of a new result or device.

Many people are called engineers who merely operate instruments, turn dials, or do other repetitive work. But such people are not engineers, even though they may have engineering degrees, and every effort should be made to make this clear to the public.

It has frequently been assumed that courses in engineering curricula should be set up to teach *all* that the engineer should know about a given subject. But such an aim is futile, because of lack of time and because the instructor himself does not know everything. Furthermore, at the time he is a student, the art itself does not possess what the engineer will need to know ten years later.

The cultural value of the engineering way of thinking should not be overlooked in our post-war educational planning. The engineer has a way of life, a mental directness and vigor, which is useful in the solution of many of mankind's problems. The social scientist, the physician, the lawyer, the politician, the preacher, and many others can learn from him as well as teach him. We should give serious consideration to providing some such course as the "Philosophy and Methods of Engineering" for the cultural education of non-engineers. If our methods were known, workers in other fields could frequently frame their problems so they could be brought to engineers for solution and great additional good would result.

W. L. Everitt is Director of Operational Research Staff, Office of the Chief Signal Officer, U. S. Army. He has recently been appointed professor and head of the Department of Electrical Engineering, University of Illinois. He is also president of the Institute of Radio Engineers. **The paper from which the above material was abstracted appeared simultaneously in recent issues of the Proceedings of the IRE and the Journal of Engineering Education of the Society for the Promotion of Engineering Education. It is used by special permission of the Journal.** **In view of the present educational situation, both practicing engineers and teachers of engineering have an opportunity now to make some very important decisions on what engineering education should be and should do in the future. We hope the above comments will stimulate discussion of the subject.**



Photo, courtesy, Westinghouse

600,000 KILOWATTS

This series of photographs made with a super-speed X-ray tube, shows how a 20 millimeter high explosive projectile swells, bursts and disintegrates while passing through a steel plate. The X-ray tube was developed by Dr. Charles M. Slack, assistant research director for Westinghouse Lamp Division. The tube requires the enormous sudden burst of 600,000 kilowatts of electricity to make exposures of a millionth of a second possible. The tube was specially designed to jerk electrons out of a cold metal cathode at a terrific rate of speed when a high momentary voltage is applied. A vacuum metallic arc is produced, providing a fiery tight-rope across which the electrons race until they strike the anode. The resulting barrage of X-rays pours through solid metal to make shadow pictures of the type shown above in approximately a millionth of a second.

Although shown as a single picture, actually, the illustration was made from four separate photographs. The first one, at the top of the picture, shows the nose of the shell just passing through the plate. The second view shows the shell almost half through the plate. The shell has swelled to approximately twice its diameter. In the third view the shell has just burst open. Finally in the lower view, the shell has burst wide open. The petals on the back of the plate are curling back to make a large hole.

WITH THE EDITORS

Electricity on the Farm—Before the war, almost 100 per cent of the farms in Holland were electrified; in Germany the percentage was 95 and in Denmark, 85 per cent. According to various estimates and statistics, somewhat less than 50 per cent of the farms in the United States are electrified.

This comparison must not be taken at its face value, however. The European countries referred to are small in comparison to our country; they are old, closely organized and densely populated and the people are of uniform temperament. The United States is still a new country, its areas are vast and far flung, its people less integrated into a socially uniform whole. It is not to be expected that all of the scattered farms throughout the whole of this land can be served with central station electric service at any time in even a reasonably near future.

The average farmer in this country, however, is still very much in need of central station electric service. In the factory, electric power has been put to good use, whether it comes from central electric stations or whether it is produced by privately owned industrial power plants. As a consequence, more factory-made goods are produced at less cost than before such power was available. Electric power has multiplied the output of our factory workers many times which has resulted in higher wages.

The farmer is in more or less direct competition with the factory worker, and unless he also has the help of electricity, he is at at great disadvantage. Even if the farmer does not use electric power in the actual tilling of the soil, or in the harvesting of crops, he needs it to do the many other things that have to be done on a farm. He needs it also to raise his standard of living; to provide him with light, to pump water, for cooking and water heating, to operate his radio and all the other electric appliances which bring comfort and convenience in the home. He wants the conveniences of the city folks and because he wants them he is *going to get electric service*, regardless of from whom he gets it. If the electric light companies do not make it available to him, he will get it from municipal or co-operative systems.

REA's First 10 Years—During the past 25 years considerable progress has been made in making electric power available to the farmer. Last month, on May 11, to be exact, the Rural Electrification Administration completes its first ten years of service in this direction. On May 11, 1935, President Roosevelt issued the executive order creating the REA. The REA has done a good job both in providing electric service to the farmer and in stimulating the electric utility companies to increase their efforts in providing electric service to the farmer.

The electric utility companies began to give serious consideration to extending their lines to the farms in the 1920's. They pioneered the new development work and solved many of the problems created by the development and extended service to the farmers from the early 1920's to the time they were stopped by the depression in 1930. During this period, the utilities built hundreds of thousands of miles of farm electric lines and made service available to almost 1,000,000 farms.

With the formation of the Rural Electrification Administration, the whole question of rural electrification received new impetus. The REA began a systematic effort to reduce the costs of rural line construction. This had been, and still is, one of the main obstacles to the extension of rural service. More economical line equipment was designed, longer line spans were developed, cumbersome, unwieldy lines gave way to streamlined construction that brought costs down to below $1,000 a mile.

Two Million to Go—With improved economic conditions in 1935 and the competitive influence of the REA, the electric utilities again began to extend rural lines. As in all conflicts between business interests and those of government, ill-feeling and bitterness developed between the two groups involved and many "incidents" occurred which lend little prestige to our so-called system of free enterprise. On the whole, however, the work has gone forward satisfactorily and at the present time there are some 2½ million farms in the United States using electric service. Of these approximately 1,600,000 are served by electric companies, about 800,000 by REA co-ops, and about 80,000 by municipal systems.

This is a good beginning but it has been estimated that of the total 6,090,789 farms listed in the 1940 U. S. Census, some 4,500,000 can use electric service to good advantage. The task of extending the electric service lines to these remaining 2,000,000 farms is one well worthy of the attention of all concerned, the utilities as well as the co-operative and municipal systems.

The Little Man Who Wasn't Here—During the past year or so, many engineers have wished he would come back soon—the cub engineer, the cadet engineer, the apprentice engineer.

He was the lad you could always send to calibrate a meter, to make sure that the piping from the pulverizer exhausters got properly packed, and all the details of that sort that are always coming up around the power plant. You had gotten him to the point where, if nobody else was available to pack that boiler feed pump, he not only could but would turn to and do it with his own hands, and when he got through you knew it was done right.

You really begin to appreciate him when you find that there literally isn't anybody else you can send down to pack that feed pump. Every other available man is working on something just as important and can't be taken off it. There is only one thing to do and that is go down and pack it yourself. It takes just that much time from something else equally important.

Well, we all wish he'd come back. We know he can't come back now because he has something much more important to do and is doing it magnificently. But we think one day soon when he sticks his head in the office door, grins from ear to ear and says, "Hello, Chief, have I still got a job here?" you are going to be mighty glad to see him.

Inside Story—The world's fastest x-ray machine which made it possible to take the photographs shown on the opposite page in a millionth of a second or less, is giving ballistics experts the "inside" story of what happens to high-velocity projectiles as they rip through thick armor plate.

Discharging a stream of x-rays 50 times faster than the average lightning bolt, the new machine can take pictures through one inch thick steel, showing the behavior of a projectile or gun from the instant of firing until the target is hit.

Oddly enough, the success of this new device is based on a weakness in the conventional x-ray machine. Occasionally, such tubes backfire and discharge many thousands of times the amount of current normally required for relatively low speed work.

Dr. Charles M. Slack, Assistant Director of Research at the Westinghouse Lamp Division, studied this weakness and concluded that it held the germ of ultra-high-speed radiography. Together with assistant Louis F. Ehrke, he developed a machine that discharges a million times the current of the conventional x-ray tube, and is hence many thousands times faster.

The two men experimented with the machine in a variety of ways. They fired high-speed .22 caliber rifle bullets into sandbags, took pictures of vacuum cleaners and electric shavers in operation, x-rayed a golf ball at the instant it was driven from the tee. To learn the internal damage caused by high-velocity projectiles striking the human body, they even photographed a meaty soup bone as it was smashed by a bullet.

Post-war-wise, the millionth of a second machine holds great promise as an industrial and medical tool.

Power and Steam *for the* NAVAL AIR STATION

Five thousand kilowatt power station supplying most of the steam and electrical energy used at the great Naval Air Station at Quonset Point, R. I., delivers power at the switchboard at a maximum cost of 3.8 mils per kwh. This attractive and efficient plant, designed by Gibbs and Hill, Inc., of New York was built in the fall of 1940 and extended in 1942 and 1943 to meet the expanding needs of the air station. Extraction-condensing steam turbines supply electrical energy as well as steam for the laundry, the galley and for heating buildings and workshops.

MANY EFFICIENT and well-designed power plants have been built at various bases and training establishments of our armed forces during the past four years. Among these, one that is outstanding not only because of its good engineering design but also because of its attractive layout and appearance, is the power plant at the United States Naval Air Station at Quonset Point, Rhode Island, located not far from the city of Providence. This power plant together with a small "booster" boiler plant supplies practically all of the steam and about 85 per cent of the electrical requirements of the Air Station and associated establishments.

The design of this power plant was begun in the fall of 1940, and construction of the initial installation, consisting of 3—65,000 lb per hr, oil fired boilers and 2—2500 kw turbo-generators was completed earily in 1941. The plant, called Plant No. 1, operated satisfactorily within the limits of its design and with very few outages. In the fall of 1942 as a result of our entrance into the war, the Air Base expansion program progressed far more rapidly than the ability of the power plant to supply the demand for steam and, as a fill-gap, a "booster" plant was hastily planned and constructed to carry a portion of the steam load for the balance of 1942 and 1943. This booster plant, known as Plant No. 2, consisted of two Wickes vertical boilers with Murphy stokers. These were old units, brought to Quonset Point after they had operated at a midwestern location for more than a quarter century. The booster plant is located a short distance from the main power plant. The construction of this booster plant was purely an emergency measure to meet the pressing steam needs of the moment.

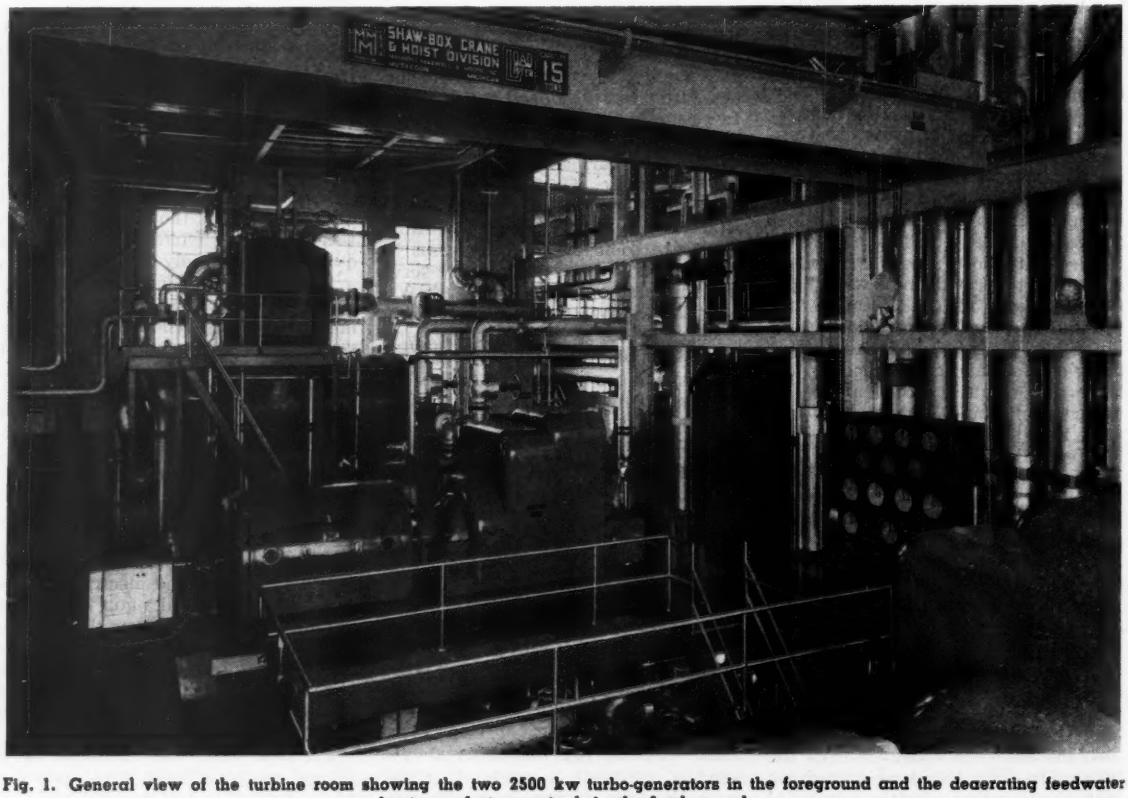


Fig. 1. General view of the turbine room showing the two 2500 kw turbo-generators in the foreground and the deaerating feedwater heater and storage tank in the background

AT QUONSET POINT, R. I.

By Andrew W. Kramer

Managing Editor

In addition to the hurried installation of the booster plant, plans were made shortly afterwards for the installation of a fourth 65,000 lb per hr boiler at the main plant. This unit was installed in a space provided by a slight extension to the original boiler room. The installed capacity at the Station at the present time, including the boilers at the booster plant, is capable of producing 310,000 lb of steam per hour. During 1944 Plant No. 1, generated 1,180,428,000 lb of steam and Plant No. 2, 87,623,170 lb, a total for the two plants of 1,268,051,170 lb. The overall thermal efficiency of the boilers at Plant No. 1 during 1944, was 83.92 per cent.

The boilers at the main power plant generate steam at 380 psi, which is the pressure at which the two turbo-generators are designed to operate. The steam for building heating and other purposes throughout the Station is distributed at 100 psi. This 100 lb steam is obtained from extraction points on the turbines. At times when there is not enough extraction steam to supply the heating requirements, additional 100 lb steam is supplied through a reducing valve and desuperheating station from the 380 lb mains. Loads are tapped off the main 100 lb distribution line and reducing valves provided to reduce the pressure from 100 to 30 psi for the laundry, galley and miscellaneous uses and for further reduction to 5 psi at each building to supply the heating demand.

Engineering Features of the Main Power Plant

The general arrangement of equipment in the Quonset Point Power Plant No. 1, is shown in the accompanying plan and elevation and in the photographs. Note that, except for the condensing equipment and the coal pulverizers on the basement floor level, practically all of the equipment is installed on the operating floor level, a feature which makes for convenience in operation and maintenance.

The four boilers are set, individually, in a single row, facing the turbine room, and there is no dividing wall between the boiler room and the turbine room. The two 2500-kw turbo-generators are located on either side of a large open hatchway giving access to the condensing equipment on the basement floor below and the deaerating feedwater heater and storage tank are installed at the end of the turbine room. The deaerating heater is a vertical, non-storage Hoppes Mfg. Co., heater mounted on top of a 5000 gal storage tank. The heater is equipped with vent, condenser and accessories and is easily accessible by means of a small steel platform and stairway.

All main and auxiliary steam piping as well as the boiler feed discharge piping is seamless steel meeting ASTM standards, with welded joints. Low pressure steam and water piping is either lap welded or seamless steel. An interesting feature of the main steam piping is the location of the high pressure steam manifold on the operating floor level between the boiler room and the turbine room. This places the valves in all the main steam leads to the turbines and to the boilers within easy reach of the operators.

The turbo-generating units are Westinghouse machines, each consisting of a 370 psi, 570 F, extraction-condensing turbine, direct connected to a 3570 kva, 100 per cent power factor, 4160 v, 3 phase, 60 cycle, 3600 rpm generator with direct connected exciters. Extraction pressures range from 90 to 130 psi. At normal capacity of 2500 kw, the units will deliver approximately 90,000 lb of extraction steam per hour and 100 psi.

Each turbine exhausts into a 2310 sq ft Westinghouse surface condenser set transverse to the main axis of the turbine. The generator air coolers, the oil coolers, air ejectors with their inter- and after-coolers, and condensate pumps are all located on the condenser floor, as are also the two boiler feed pumps. All of these essential auxiliaries, including the condensers are protected by solid concrete flood walls which extend 10 ft above the basement floor. In September, 1944, when high water due to the hurricane flooded the flying fields and the ground around the power plant to a depth of from 3 to 4 ft, no water entered the area in which these auxiliaries were located. This demonstrated the necessity for the provision of the flood walls and this one experience more than compensated for the extra cost involved in building the walls. All other critical equipment in the power plant with the exception of part of the pulverized fuel equipment is adequately protected behind flood walls.

Dynamic Color Scheme

One of the most attractive features about this station is the interior color scheme. This makes use of a system of painting developed by the Pittsburgh Plate Glass Co., involving what they call "color dynamics." This system has been widely applied in factories and industrial plants but until its application at the Quonset Point power station it had not been used very much in power plants. This system of painting has as its object not only the creation of an attractive interior but also the reduction of eyestrain and consequently, the reduction of personal injury to attendants and workers. Color Dynamics is concerned not only with the background of walls, floors and ceilings but also with the machinery. Methods for painting machinery have been developed which reduce the danger of personal injury and minimize eyestrain. The theory underlying this system is that machines and the critical or operating parts of machines should be given colors that come quickly to the eye—colors that "pop up" in strong contrast to the stationary or non-critical parts must drop back. This is accomplished by painting the bodies of machines in a *receding color*. At the Quonset Station, the receding color used on most of the machines, that is, the turbo-generators, fans, pumps, motors, etc., is what is known as *vista green*.

The ceilings are painted in what is called a *cascade blue*. This is a soft, light shade which throws the ceiling into the background. The walls are

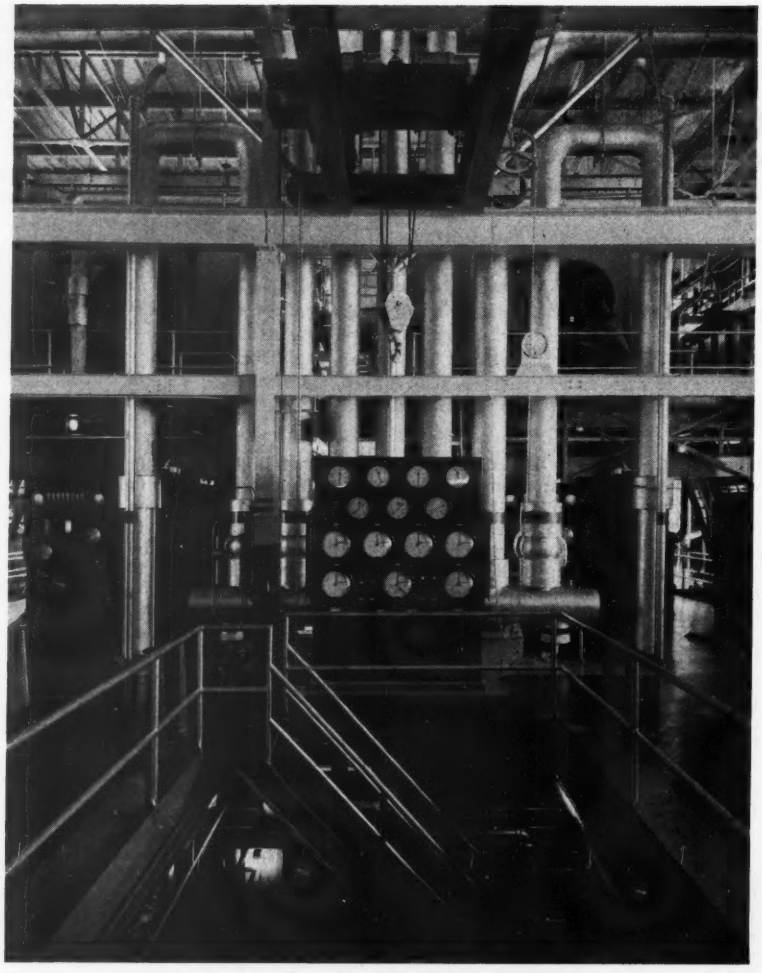


Fig. 2. There is no dividing wall between the boiler and turbine room. This view, looking toward the boiler room, shows the turbine instrument panel and the main high pressure steam manifold just behind it. This manifold is placed close to the operating floor within easy access of the operators

painted a soft yellow tone against which the machines stand out in sharp contrast. The floors are grey with all traffic lanes in a dark brown Mastipane with vivid stripes of orange along the edges to serve as boundary lines. The piping for the most part is painted in an aluminum color with coded bands of different colors to denote the service. The 15 ton traveling crane which runs the full length of the turbine room is bright yellow.

The entire color scheme presents a most pleasing appearance. While the question of safety to operators is not as important in a power station as it is in a factory with machines with many moving parts, the reaction of the operators at Quonset is decidedly favorable. Among other things, it makes for good maintenance and neat housekeeping.

Plant Designed to Burn Either Coal or Oil

Originally, the plant was designed to burn fuel oil, space being provided for installation of ash hopper and pulverizers at ground level for future installation, should coal be used. But after its construction and initial operation when the fuel oil supply was critical on the Atlantic coast, complete equipment was installed to make possible the conversion to the use of pulverized coal and a supply of some 26,000 tons of coal was laid down. The pulverized coal equipment was given a service test and is now available for emergency use in case of failure of the oil supply. By the time the pulverized coal installation was completed, the fuel situation changed so that coal was less plentiful than oil, so at the present time, Bunker C oil is used as the normal fuel. The burning of oil, aside from its inherent convenience is advantageous because it eliminates the fly ash nuisance which affects visibility from the standpoint of flying operations. Space and arrangement suitable for cinder eliminators at ground floor level under I. D. Fans when government releases steel plate for such uses. Subsequently, 21,000 tons of the coal stored at the plant was released for other Naval bases and an emergency stock of approximately 5000 tons was retained at the station.

With oil burning and an effective automatic combustion control system, it has been possible to operate the power plant with a very small operating force. The crew on each watch consists of

1 Engine man (charge of watch)
1 Switchboard operator
2 Water tenders
1 Mechanic
2 Firemen
1 Oiler
1 Laborer

The Boilers

The boilers are Combustion Engineering Co. VU type units with a maximum capacity of 90,000 lb of steam per hour but with a normal rating of 65,000 lb per hr. The furnace is water-cooled on top, bottom and sides with 3-in. diameter tubes in circuit with the boiler. The water wall risers and downtakes are compactly arranged within the casing. The convection surface of the units consist of a front bank of 3-in. diameter tubes and a rear bank of 2-in. diameter tubes. The boiler heating surface in each of the four units is 6896 sq ft, and the water wall surface, 1699 sq ft. Although designed for operation at a maximum pressure of 425 psi, they are operated at 380 psi with a final steam temperature of 570 deg F. The boilers are entirely enclosed by removable steel panels which forms an air-tight casing.

The furnaces are designed for a furnace temperature not to exceed 2150 F and a heat release not to exceed 23,000 Btu per cu ft when the boiler is operated at 65,000 lb per hr when using pulverized coal as fuel.

The boilers are equipped with Elesco superheaters and Combustion Engineering Co. tubular air heaters. They are operated normally under complete automatic combustion control, using the Republic-Smoot system, designed for either automatic or manual operation. Each boiler is fired by combination oil and pulverized coal burners using Coen mechanical type oil burners. These are mounted one above the other. The burner arrangement provides for central admission of the fuel and primary air, with secondary air admitted tangentially through air ports on the inside front wall. This design provides for a high degree of flame stability as well as thorough mixing of incoming air, and fuel and air. Diamond soot blowers are provided.

Oil pumped from tankers to tanks then transfer pump, pumps to day storage tank. Then Elesco pumps draw the oil from the tank, pass it through the heaters and it is delivered hot to the furnaces.

Fuel oil is stored in two 10,000 bbl welded steel tanks, some distance

from the plant, 54 ft in diameter and 24 ft high with steel roofs and provided with ladders and suitable venting arrangements. An auxiliary, day storage tank buried just outside walls of plant, oil storage tank of 10,000 gal capacity equipped with an oil heater is also provided. This is a horizontal tank, 96 in. in diameter and 25 ft long. The oil is handled by an Enco steam and electric pumping and heating system, located in turbine room basement so as to be protected from floods. Plant runs on oil when pulverizers are flooded.

For coal operation the plant is provided with four Raymond pulverizing mills, one for each boiler. Each mill is designed to supply sufficient coal to operate the boiler at maximum steaming capacity with coal of 14,700 Btu per lb. The mills are driven by squirrel-cage induction motors rated at 75 hp each and made by the Louis Allis Co.

The boiler units are provided with United Conveyor water-cooled ash hoppers. These are suspended from steel work with spring supports to provide for vertical expansion. The hoppers are lined with fire brick and equipped with Durite Grids for clinker breaking and with cleanout and inspection doors. The ash is removed from the hoppers by a United Conveyor Corp. ash handling system discharging into a vitrified glazed tile circular ash storage tank located outside the building. This system removes the ash from the four ash hoppers and dust from 8 last-pass hoppers and four dust collector hoppers. The system is complete with exhauster, air washer and timer.

Coal is handled by a complete Stephens-Adamson coal handling system consisting of a skiploader, skip hoist, concrete track hopper and auxiliary equipment. The skip hoisting machine

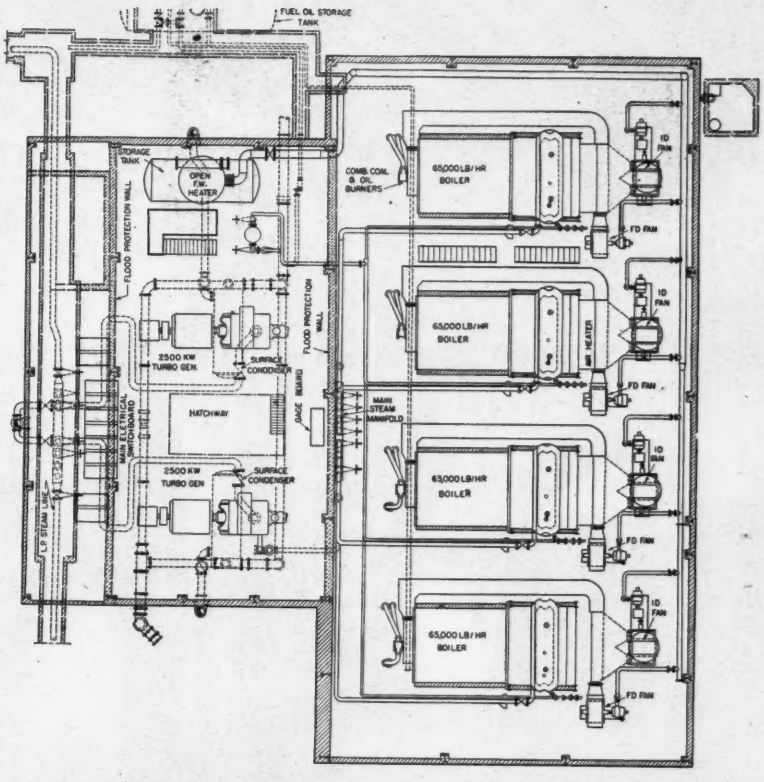


Fig. 3. Plan of the station at the operating floor level. Note the concrete flood wall which encloses vital equipment on the basement floor level

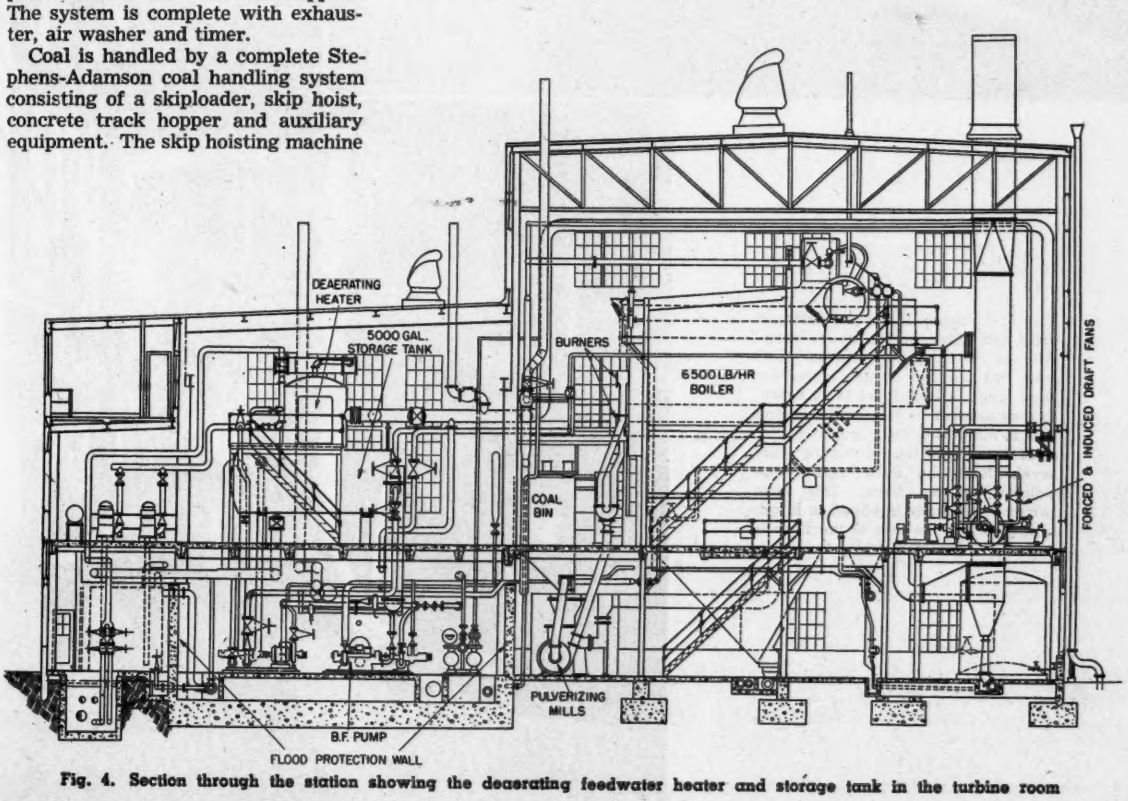


Fig. 4. Section through the station showing the deaerating feedwater heater and storage tank in the turbine room

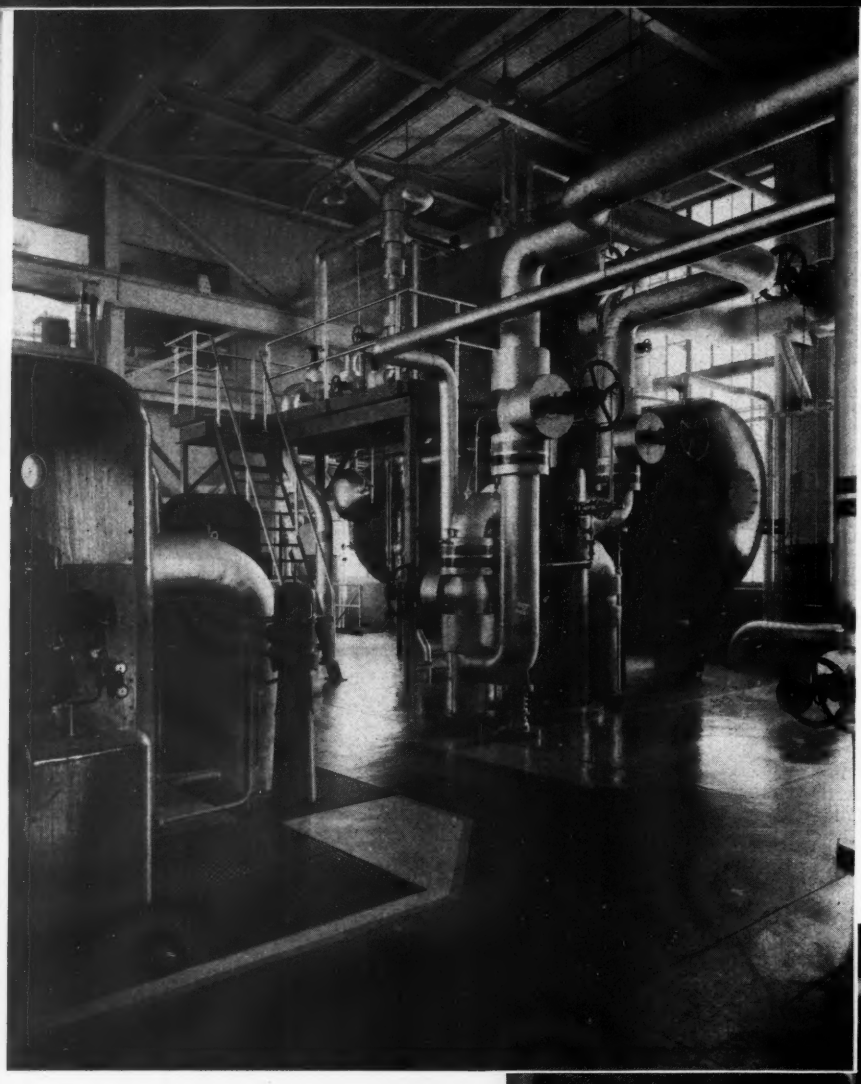


Fig. 5. This is a view of the deaerating feedwater heater and storage tank installed on the operating floor at one end of the turbine room. The steam end of one of the 2500 kw turbo-generators is seen at the left. The high pressure, closed, feedwater is mounted vertically with only the top end extending above the turbine room floor

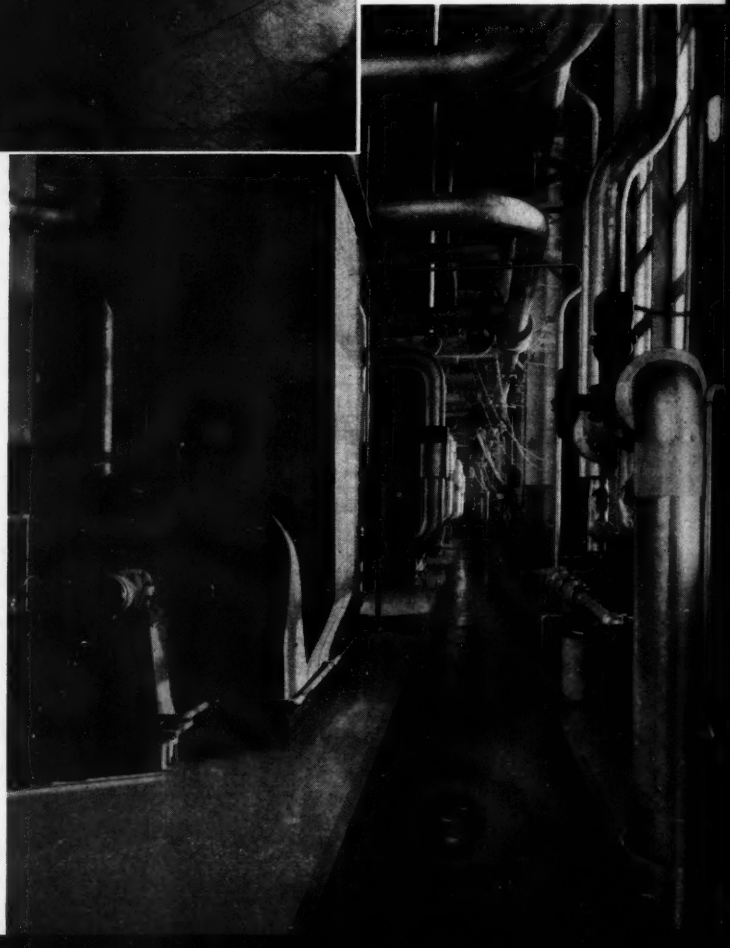


Fig. 6. Looking down the induced draft fan alley in the boiler room. All the forced and induced draft fans are located on the operating floor level, in fact, there is no essential equipment in the entire station that is not within easy access of the operators from the operating floor level. Note the dark traffic lane painted on the floor. This dark brown traffic lane is edged in bright orange while the rest of the floor is painted grey

Fig. 7. In the view at the right is shown the main electric switchboard. Electrical energy for the Air Station as well as the associated training establishments is controlled by the operator from the main generating plant. Current is generated at 4160 v. The main feed to the station is a 35 kv loop

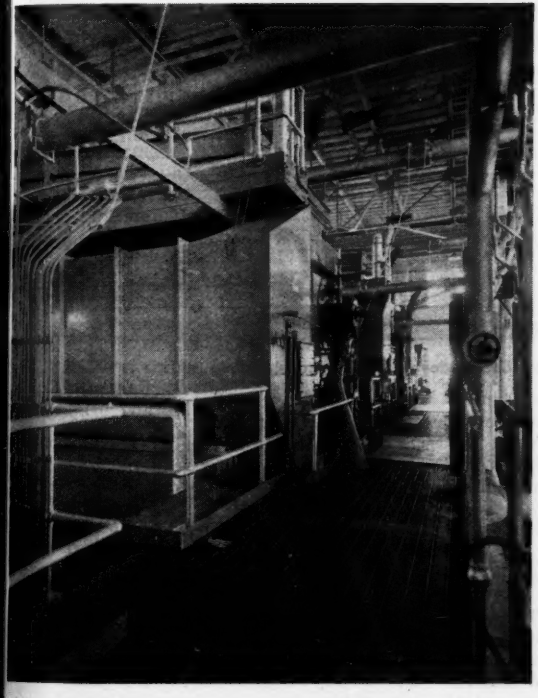


Fig. 8. This view, at the left, is one on the burner level just above the operating floor. Each of the four boilers is equipped with two combination pulverized coal and oil burners. The burner arrangement provided for central admission of fuel and primary air, with secondary air admitted tangentially through air ports on the inside front walls of the boilers. This design provides for a high degree of flame stability as well as thorough mixing of the incoming air and fuel and air. Forced draft is delivered to the front of the boilers through the ducts at the side of the boilers as shown in this photograph

Fig. 9. Each of the four boilers is served by a Raymond coal pulverizing mill. These mills, which are driven by squirrel-cage inductor motors, are located in the basement just below the burners. The coal is distributed to the pulverizers by a distributing conveyor with a minimum capacity of 30 tons per hour and equipped with four discharge openings, one for each of the four mills. Each mill is designed to operate the boilers at maximum capacity with coal having a heat value of 14,700 Btu per pound

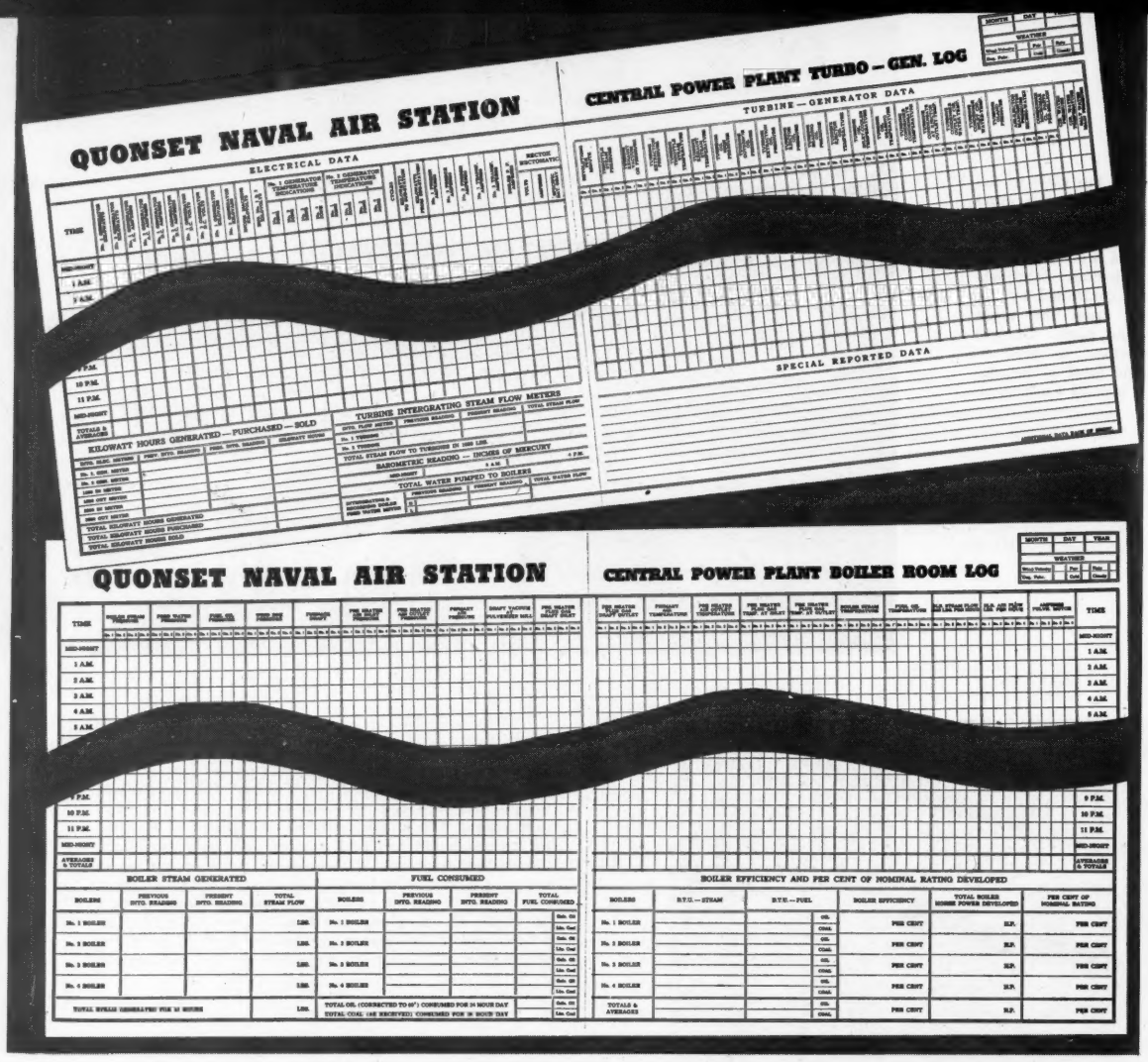

QUONSET NAVAL AIR STATION
CENTRAL POWER PLANT TURBO – GEN. LOG
ELECTRICAL DATA
TURBINE – GENERATOR DATA
SPECIAL REPORTED DATA
KILOWATT HOURS GENERATED — PURCHASED — SOLD
TURBINE INTERGRATING STEAM FLOW METERS
BAROMETRIC READING — INCHES OF MERCURY
TOTAL WATER PUMPED TO BOILERS
QUONSET NAVAL AIR STATION
CENTRAL POWER PLANT BOILER ROOM LOG
BOILER STEAM GENERATED
FUEL CONSUMED
BOILER EFFICIENCY AND PER CENT OF NOMINAL RATING DEVELOPED

Fig. 10. Reproductions of the Boiler Room and Turbine Room Log Sheets developed by the operating staff

is self-contained and designed for fully automatic operation. The coal is delivered into a 360 ton circular coal silo constructed of glazed tile on elevated supports. A coal distributing conveyor with a minimum capacity of 30 tons per hour and equipped with four discharge openings delivers the coal to the four pulverizing mills. Coal is weighed by means of a Richardson automatic scale equipped with magnetic separator.

Forced and Induced Draft

Both the forced and induced draft fans are located on the main operating floor at the rear of the boiler as shown in the drawings and photographs. The gas outlet on the boilers is at the top of the rear wall against which the air heater is located. Gases pass down through the air heater and then make a 180 deg turn. This is where gases in future will go into a cinder catcher after 90 deg turn. Then another 90 deg up into fan inlets, into the induced draft fans which deliver directly to the stacks mounted above the I-D fans. The stacks, one for each boiler, are short, stub stacks because of the flying hazard that would be introduced by the use of tall stacks.

The froced draft fans are American Blower Co. fans with a capacity of 17,000 cfm at 9.25 in WG at 100 F. They are driven by Terry steam turbines rated at 55.5 hp and using steam at 370 psi. The turbines exhaust at 5 psi into the low pressure system, supplying steam to the Hoppes deaerating heater.

The induced draft fans are also American units, rated at 33,500 cfm at 4.9 in WG, 382 F. They are driven by 108.5 hp Terry turbines through reducing gears. Both forced and induced draft fans are under the control of the combustion control system.

The fan installation is very compact and accessible as is all the other equipment in this station.

Feedwater

Feedwater to the boilers is obtained from the local town supply and is conditioned by W. H. & L. D. Betz of Philadelphia. The water is heated first in the open type Hoppes deaerating heater already referred to and then in a closed Lummus heater, the combination resulting in a temperature of 330 F. Swartwout automatic regulators control the feeding of the water to the boilers.

There are two turbine and one electric motor driven boiler feed pumps. Two Gould units driven by Westinghouse turbines and one Gould unit driven by a 250 hp electric motor. Two of these pumps have a capacity of 420 gpm at 1310 ft head while that of the other is 580 gpm at 1200 ft head. These units operate at a speed of 3550 rpm.

It will be noted that practically all of the important auxiliaries are steam driven. This, in a station where a relatively large amount of low pressure steam has to be supplied, is a desirable method of drive. Also useful in starting up an isolated plant which this was when originally installed.

Condenser Circulating Water

Condenser circulating water is taken from Narragansett Bay. The circulating water pumps are located in a screen house remote from the plant. This, naturally, is salt water and when the plant first went into operation gave considerable trouble due to the growth of mussels in the circulating water system. It was necessary to take the condensers out of service as much as three times a day to scrape the mussels off. They filled up the

tubes and water boxes. To overcome this trouble a chlorinating system was installed. Space had been provided for this in the screen house when plant was originally designed. This system which is that of the Wallace Tiernan Products Co. of Belleville, N. J., is completely automatic in its operation. It proportions the chlorine feed in accordance with the rate of water flow and since its installation no further trouble has been experienced.

Electrical Features

The two 2500 kw generating units generate current at 4160 v which is the voltage of the primary distribution system at the Naval Air Station. Additional power is purchased from the Narragansett Electric Co.

Electrical energy for the Air Station as well as for the Naval Construction Training Center, Camp Endicott, R. I., and the Advance Base Depot at Davisville, R. I., is controlled by the operattor at the main generating plant. The main feed is a 33 kv loop transmission line owned by the Navy, which feeds four substations. The power plant feeds the loop at substation No. 1 through the Naval Air Station primary distribution feeders and the Narragansett Electric Co. feeds the loop at another point from its 33 kv transmission line.

At substation No. 1 there are two transformer banks, one having a capacity of 1500 kva, 33/4.16 kv and the other 3000 kva, 33/4.16 kv. This substation No. 1 ties into the primary distribution system at the Naval Air Station. Three other substations, each containing a 3-phase 2000 kva, 33/4.16 kv transformer are located at various locations for supplying Camp Endicott and the Advance Base Depot.

The main switchboard at the generating plant is a 14-panel Westinghouse board consisting of two main generator panels together with metering and primary distribution panels. At present there are three 4160 v feeders between the power plant and substation No. 1. These feeders are 3-conductor, 5000 v, 500,000 CM varnished cambric lead-covered underground cables.

Operation

The plant is well equipped with instruments and the information they supply is entered on a specially designed log sheet that is a credit to the officers and men in charge of the station who devised it. A comprehensive statement of the station performance is thus developed each day. As will be noted from the reproductions of the log sheets on these pages, the boiler room log is kept separate from the turbine room log. In addition, there is also a weekly boiler water control report, which is mailed to W. H. & L. D. Betz.

Quantitative measurements include those of oil, water and steam. Flue gas temperatures are recorded at the boiler exits and the air heater exits; feedwater temperatures at the entrance and exists of the heaters, and steam pressures and temperatures are also recorded.

Of interest in connection with the operation of the station is the fact that most of the records are kept by a group of Navy Waves. These young women not only record the instrument readings but calculate the daily and monthly heat balance and, in addition, also make orsat analyses and other special tests.

Because of the splendid design and attractive appearance of this station, the operators and attendants take special pride in its operation and maintenance. A typical set of boiler plant data is shown in Table I. This, it will be noted, shows an average overall boiler efficiency of over 80 per cent. Table II and III presents general data on the operation of both plant No. 1 and plant No. 2 during 1943 and 1944. It is significant that the efficiencies listed in the heat balance in Table I, based on the combustion tests, check the yearly average for plant No. 1 shown in Table II. The evaporation per pound of oil, from the heat balance, it will be noted, averages 15.21 lb, while the 1943 figure arrived at by the plant records, amounts to 15.27 lb.

The average cost per kw of electric energy at the bus for the month of May is 3.8 mils. The analysis of cost for each of the turbo-generators is indicative for extreme conditions and is as follows:

Analysis of Costs on Unit No. 1.

Analysis of cost for No. 1 Turbo-generator for month of May. The cost $0.3604 per thousand pounds of steam delivered for the first ten months of the year, taken as average.

(a) When running condensing, the ultimate cost per kilowatt at the bus was $0.00406.

(b) When running extraction-condensing, the ultimate cost per kilowatt at the bus was $0.00352.

(c) Thus the cost when operating on power balance was $0.00406, and

Table I. Typical Data on Boiler Operation, Plant No. 1

AVERAGE OBSERVATIONS			
Date	3/22/44	3/23/44	3/23/44
Boiler Designation	No. 1	No. 2	No. 3
Lbs. steam per hour	56100	64600	67100
Steam pressure, psi	385	385	385
Steam temperature, deg	580	600	577
Feed water temperature, deg	330	330	330
Flue gas temperature, at air heater exit, deg	380	402	423
Air temperature to burners	350	345	358
CO_2 percentage at air heater exit, deg	11.8	12.3	11.8
Uptake draft at air heater exit, in.	0.24	0.29	0.24
Furnace draft, in.	0.17	0.15	0.15
Windbox pressure, in.	2.10	2.60	2.70
HEAT BALANCES			
Controllable loss: Dry gas	7.8%	7.6%	8.4%
Uncontrollable loss: Hydrogen in oil	6.5%	6.5%	6.6%
Total Measurable losses	14.3%	14.1%	15.0%
COMBINED EFFICIENCY	80.7%	80.9%	80.0%
Unaccounted for losses (assumed)	5.0%	5.0%	5.0%
	100.0%	100.0%	100.0%
BTU per lb steam	997.2	1008.9	995.4
Evaporation per lb oil, lbs	15.29	15.15	15.18

Table II. Data on Operation During 1943

Steam Generation	
Total lb steam generated at No. 1 plant	776,755,400
Total lb steam generated at No. 2 plant	82,438,000*
Grand total lb steam generated	859,193,400
Total gal oil consumed at Plant No. 1	6,539,900
Total lb coal consumed at Plant No. 2	9,688,000
Thermal overall efficiency No. 1 plant	80.86%
Thermal overall efficiency No. 2 plant	63.75%

N. B. Taking December as a representative cold month, the average steam generation station-demand approximated 249,401 lb/hr.

Electrical Generation	
Total Kilowatt-hours generated	15,998,520
Total Kilowatt-hours purchased	6,518,083
	22,516,603
Total Kilowatt-hours sold to other Naval activities	824,870
Total Station requirements	21,691,733

Table III. Data on Operation During 1944

Steam Generation	
Total lb steam generated at No. 1 plant	1,180,428,000
Total lb steam generated at No. 2 plant	87,623,170
Grand total lb steam generated	1,268,051,170
Total gals oil consumed at Plant No. 1	9,444,340
Total lb coal consumed at Plant No. 1	500,000
Total lb coal consumed at Plant No. 2	12,089,877*
Thermal overall efficiency No. 1 Plant	83.92%
Thermal overall efficiency No. 2 Plant	52.11%

*Weight of fuel used at No. 2 Plant estimated. This Plant operating under banked conditions over a wide range of the period.

N. B. Total recorded load for January 24, 1945, approximated 330,000 lb steam per hour, weather conditions; mean wind velocity 17 miles per hour, mean temperature of 70°F.

Electrical Generation	
Total Kilowatt-hours generated	28,885,000
Total Kilowatt-hours purchased	2,901,026
	31,786,026
Total Kilowatt-hours sold to other Naval activities	3,084,633
Total Station requirements	28,701,393

when operating extraction-condensing, the cost was $0.00352.

(d) The overall cost per kilowatt-hour was: Kw, 1894 condensing + kw, 1763 extracting = 3657 kwh

$$\frac{\$7.6970 + \$6.2208}{1894 + 1763} = \$0.00380$$ average cost per kwh.

Average Cost Per Kilowatt-Hour = $0.00380 at the Bus.

Analysis of Costs on Unit No. 2
(Also for May)

(a) When running condensing the ultimate cost per kilowatt at the bus was $0.00495.

(b) When running extraction-condensing the ultimate cost per kilowatt at the bus was $0.00268.

(c) Thus the cost when operating on a power balance was $0.00495, and when operating extraction-condensing, the cost was $0.00268.

(b) The overall average cost per kwh was: Kw, 1610 condensing + kw, 1596 extracting = 3206 kwh

$$\frac{\$7.9763 + \$4.2783}{1610 + 1596} = \$0.00382$$ average cost per kwh.

Average Cost Per Kilowatt-Hour = $0.00382 at the Bus.

The cost data for the month of May, 1943, is indicative for possible extreme generating conditions. The ultimate yearly cost is predicated on two factors. The Station is designed primarily as a steam heating plant with the generation of electrical energy as a by-product. To arrive at the ultimate cost of generating 1000 lb of steam, the total power plant charges, consisting of labor, material, maintenance and operating cost, but not including first investment or interest charges, as submitted by the accounting division for the period starting July 1, 1943, to May 1, 1944,

List of Principal Equipment Installed in Quonset Point Naval Air Station Plant No. 1

General

Type: Steam Electric Generating Plant.
Owners: U. S. Navy.
Location: Quonset Point, R. I.
Consulting Engineers: Gibbs & Hill, Inc., New York, N. Y.

Boiler Equipment

4 Combustion Engineering Co. VU Type, oil and pulverized coal-fired boilers. Maximum capacity, 90,000 lb per hr; normal operating capacity, 65,000 lb per hr. Wp, 380 psi, final steam temp at superheater outlet, 570 F, when feedwater temp is 324 F. Furnaces, water-cooled, top, bottom and sides. Designed for furnace temp not to exceed 2150 F, and heat release not to exceed 23,000 Btu per cu ft per hr when boiler is operated at 65,000 lb per hr, using pulverized coal as fuel.

1 Republic Flow Meters Co. Automatic Combustion control system of the air-operated type with individual control for each boiler with a master steam pressure element installed on the center boiler panel which develops air-loading pressures as a function of the steam demand on the boiler plant. The control is guaranteed to equal the following tolerances when in operation:

± 1 per cent steam pressure
± 0.02 in. H_2O furnace pressure
± ½ per cent CO_2

Combustion control furnished complete with boiler meters, temperature recorders, 6-point indicating draft gages, recorders for indicating, integrating and recording turbine throttle flow, recording turbine throttle, steam temperature and turbine throttle steam pressure, turbine exhaust pressure, bleeder steam pressure, bleeder steam temperature, water pressures and temperatures, oil pressures, etc.

4 Combustion Engineering Co. tubular air heaters.

4 Diamond Power Specialty Co. soot blower systems, one for each boiler. These units are of valve-in-head type using steam from the superheater header.

4 Combustion Engineering Co., Elesco superheaters, designed to give at full rating a total steam temperature to steam of 570 F with 14 per cent CO_2 in gases.

4 Boiler panels equipped with Republic comb. control mechanisms, Bailey Meter Co., steam-air flow recording and integrating steam flow meters and air and gas temperature recorders.

4 Coen Co. oil burner installations, one set for each boiler.

4 United Conveyor Corp. water-cooled ash hoppers, one for each boiler. Each hopper suspended from steel work with spring supports to provide for vertical expansion. Hoppers lined with fire brick and equipped with Durite grids for clinker breaking and cleaning and inspection doors. Hopper capacity sufficient to take care of all refuse while operating at 80,000 lb of steam per hr.

Forced and Induced Draft Fans

4 American Blower Corp. forced draft fans, capacity 17,000 cfm at 9.25 in. WG at 100 F direct connected to

4 Terry Steam Turbine Co., 55.5 hp, 370 psi, 570 F steam turbines exhausting at 5 psi gage

4 American Blower Corp. induced draft fans, 33,500 cfm at 4.9 in. WG, 382 F driven through reduction gears by

4 Terry Steam Turbine Co., 108.5 hp Type ZS-1 steam turbines. Steam pressure, 370 psi, 570 F, exhaust pressure 5 psi, gage.

Pulverizing Mills

4 Combustion Engineering Co., Raymond Pulverizing mills. Each mill designed to furnish coal for producing maximum 80,000 lb per hr, at 380 psi when supplied with coal of 14,700 Btu per lb. These mills are driven by

4 Louis Allis Co. squirrel-cage induction motors.

Coal and Ash Handling

1 Stephens-Adamson Mfg. Co. complete coal handling system, consisting of skip loader, hoisting machine, concrete track hopper, enclosures, etc

1 Richardson Scale Co. automatic coal scale with magnetic separator

1 Coal silo circular, constructed of vitrified glazed tile on elevated supports. 24 ft ID diameter, 35 ft high. Capacity, 260 tons

1 Coal distributing conveyor. Minimum capacity, 30 ton per hr, equipped with 4 discharge openings of sufficient capacity to handle coal while plant is producing 275,000 lb steam per hr

1 United Conveyor Corp. ash handling system. Unit receiver and dust separator. Venturi exhauster, air washer, timer, large hollow tile ash storage tanks. Complete conveyor system with platforms, walkaway, ladder piping, etc

1 United Conveyer Corp. system for conveying ash from 4 hoppers, 8 last-pass hoppers and 4 dust collector hoppers to ash receiver and then to ash storage tank

2 Fairbanks-Morse Co. ash hopper cooling water pumps, 100 gpm driven by

2 Fairbanks-Morse Co., 208-416-v, 1730 rpm induction motors

Boiler Feedwater System

3 Goulds Pumps, Inc., boiler feed pumps. Centrifugal. Two rated at 420 gpm at 1310 ft head, 3550 rpm, other, 580 gpm at 1200 ft head

2 Westinghouse Electric & Mfg. Co., steam turbines for driving boiler feed pumps. One rated at 229 hp, the other at 236 hp and a Westinghouse 250 hp induction motor. Both turbines operate at 370 psi, 500 F.

1 Hoppes Mfg. Co. vertical, non-storage deaerating feedwater heater, direct-contact type, mounted on a 5000 gal horizontal storage tank equipped with vent, condenser and accessories. Capacity, 275,000 lb per hr. Steam operating pressure, 5 psi

1 Lummus Co. closed type feedwater heater. Designed for pressures of 150 to 600 psi. Temp 220 F to 325 F with steam at 100 psi. 390 F. Max load 275,000 lb per hr

4 Swartwout Co. feedwater regulators. Feedwater regulators and differential pressure valves. Regulators to maintain normal water levels at 30,000, 60,000 and 90,000 lb of steam output

1 Cochrane Corp. continuous blowdown system. 1 flash tank, working pressure 5 psi equipped with copper cooling coils, blow down valves and all accessories. Normal cap. 4 boilers while operating at 60,000 lb per hr per unit. Maximum, 275,000 lb per hr

2 Leeds and Northrup Co. Micromax units. Parts per million Cl. Range O-175

1 Leeds and Northrup Co. conductivity indicator. Switchboard type for blowdown service

Turbo-Generator Equipment

2 Westinghouse Electric & Mfg. Co. turbo-generating units consisting of a 2500 kw, 370 psi 570 F extraction-condensing type turbine, direct connected to a 3570 kva, 100 per cent pf, 4160-v, 60 cycle, 3-phase, 3600 rpm generator. Turbine designed for extraction pressures 90 to 130 psi, normal operating range at 2500 kw on generator. 90,000 lb of steam per hr extraction at 100 psi

2 Westinghouse Electric & Mfg. Co. surface condensers, 2310 sq ft, equipped with float, sump controlled

2 Westinghouse Electric & Mfg. Co. generator air coolers, water tube type, 975 sq ft of surface

2 Westinghouse Electric & Mfg. Co. oil coolers. 105 sq ft

2 Westinghouse Electric & Mfg. Co. centrifugal type direct driven condensate pumps. Driven by Westinghouse motors

1 Westinghouse Electric & Mfg. Co. centrifugal type, turbine driven condensate pump

2 Westinghouse Electric & Mfg. Co. air ejector, inter- and after-condenser type. Capacity 115 sq ft, steam pressure 370 lb

2—3200 Condenser water circulating pumps driven by 2—40 hp induction motors

1 Turbine gage board containing high and low pressure steam indicating gages, feedwater indicating gages, vacuum indicating gages, salt water circulating indicating gages as well as temperature indicating gages

1 Westinghouse Electric & Mfg. Co. 14 panel vertical switchboard

Miscellaneous Equipment

1 Engineer Company Enco, steam and electric fuel oil pumping and heating system using a Quimby screw-type fuel oil pumps. Capacity, 40 gpm against 315 ft head. Quimby pump driven by 20 hp induction motor. System also has a Warren, duplex, reciprocating steam fuel oil pump

1 Griscom Russell oil heater. Maximum working pressure, 400 psi, containing 125—⅝ in. tubes

2 Elliott Co. duplex type twin oil strainers

1 Lummus Co. open type suction fuel oil heater equipped with Powers heat regulator

1 Viking rotary gear type 150 gpm fuel oil pump driven through Falk reduction gear by General Electric Co. induction motor

1 Worthington Pump & Machinery Corp. 150 gpm fuel oil pump with Westinghouse gear reducer and driven by Westinghouse 10 hp induction motor

1 Patterson-Kelly open type suction fuel oil heater equipped with Fulton heating regulator

2 Bethlehem Steel Co. 10,000 bbl welded steel fuel oil storage tanks, 54 ft diameter, 24 ft high, steel roof, with ladders, vent, etc

1 Auxiliary fuel oil storage tank, capacity 10,000 gal, equipped with oil heater, sump pump connection, etc., 96 in. diameter, 5 ft-4 in. long

1 Bowser, Inc., oil filter

1 Delaval Centrifugal oil purifier

1 Honan-Crane oil purifier

1 Manning, Maxwell & Moore, Inc., Shaw-Box, 15-ton double I-beam crane complete with motor operated hoist and head rack bridge with trolley

2 Republic Flow Meters Co. desuperheating and reducing station. Max. capacity, 90,000 lb per hr. Initial pressure 370 psi 570 F to 100 psi, 400 F. Valve design to maintain pressure range from 95 to 135 psi at discharge end of station

1 Ingersoll-Rand Co. air compressor equipped with I-R after cooler driven by 5 hp G. E. Induction motor

1 Worthington air compressor, radiator air cooled with large storage tank, driven by Westinghouse 5 hp induction motor

1 Mason-Neilan desuperheating station for laundry

1 Brown Instrument Co. portable potentiometer, range 0 to 2000 F

inclusive, provide the basis for arriving at the unit cost. On this basis the cost of generating 1000 lb of steam for all services, is $0.3604. The amount of steam chargeable per hour to electric generation is calculated at 10,474 lb. The ultimate cost of producing a kilowatt-hour at the bus is $0.0027. For comparison with the indicated cost data for 1943, it is interesting to note that the cost of generating 1000 lb of steam for all services in 1944 was $0.329 and that the amount of steam chargeable per hour to electric generation was calculated at 16,687 lb. The ultimate cost of producing a kwh at the bus in 1944 was $0.0028.

Conclusion

In concluding this description of this station, we wish to acknowledge our indebtedness to the officers and civilian executives at the Quonset Point Air Naval Air Station, and to Gibbs & Hill, Inc., for assistance in supplying much of the data used in its preparation.

The plant was designed by Gibbs & Hill, Inc., consulting engineers of New York City with John H. Hochuli, as mechanical engineer.

Capt. R. V. Miller and Lt. N. W. Southworth were in charge of construction and design for the Navy when the project was planned and built.

Capt. H. W.Johnson (C.E.C.) U.S.N. is the officer in charge of Construction and Public Works Officer for all Naval shore establishments coming under military jurisdiction of "Commander, Naval Air Bases, First Naval District." In addition, Capt. Johnson is also Officer-in-Charge of Construction and Public Works Officer at the U.S. Naval Air Station at Quonset Point. Comdr. P. M. Jeffords (CEC) USNR is the Deputy Public Works Officer and Lt. Comdr. P. J. Simmons, (CEC) USNR is Administrative Assistant.

The operation of steam and electric utilities at Quonset Point is under the supervision of Lt. Cmdr. T. B. McGlashen (CEC) USNR, who is designated, "Power Superintendent." Lt. Cmdr. McGlashen is an officer of unusual ability in the power field and much of the success in the operation and efficient performance of the Quonset Power Station is due to this able direction.

The Inside Story

COAXIAL CABLE, now used in a few long-distance telephone trunk-lines and quite extensively in military radio-frequency communications links, should experience tremendous postwar expansion in use. The American Telephone and Telegraph Company has recently announced a tentative plan to spend $100,000,000 during the next five or six years on coaxial cables to perfect long-distance circuits and to supply service to chains broadcasting television and FM.

Coaxial cable, a simple electrical structure known in theory since 1897, can guide within its shell and parallel to its axis electromagnetic (radio) waves covering an extremely wide band of frequencies, thus enabling it to carry television images or as many as 500 simultaneous telephone conversations. It has the unique advantage that at high frequencies it is an almost perfect shield against radiation from the cable and external interference from atmospheric static or crosstalk from nearby circuits. In transmitting high-frequency waves the cable absorbs some power, but serious loss in signal strength over long distances can be offset by amplifiers, known as repeaters.

The cable itself consists of an inner conductor, usually a single copper wire, surrounded by a concentric conducting tube. In some coaxial cable, the wire is held in the center of the tube by disc-shaped spacers or spirally wound string of insulating material. The free space is filled with air, or with compressed air or nitrogen if moisture may be present. If the voltage between conductors is apt to be high, solid continuous non-conducting materials, preferably flexible plastics, may be used for insulation and separation, although they may increase transmission loss. Flexible polyethylene plastic, production of which was recently initiated in the United States for this purpose, is used in large volume. Short rigid sections of polystyrene, linked together by joints, may also be the insulating medium. The outer conductor is protected by a jacket of vinyl chloride plastics or a lead sheath.

Experimental Telephone Unit

The first American telephone exploitation of coaxial cable was an experimental unit installed between New York and Philadelphia in 1936. This includes two 0.3 inch coaxial units together with eight conventional circuits for maintenance use, enclosed in a lead sheath about ⅞ in. in outside diameter. One coaxial unit is for eastbound transmission, the other for westbound. As now equipped with amplifiers at intervals of about five miles, the unit transmits a frequency band about 2000 kilocycles wide for telephone use. Since each telephone conversation employs a frequency band of four kilocycles, about 500 simultaneous two-way conversations can be sent over this cable. Each group of signals representing one conversation is transmitted over the coaxial cable as though each of 500 radio stations with different carrier frequencies were broadcasting the conversation. All these signals may be placed in the cable by suitable transmitting equipment, then separated at the receiving end and connected to telephone circuits.

Commercial Telephone Applications

Besides the experimental line, there are now three commercial installations of long-distance coaxial telephone cable — between Minneapolis and Stevens Point, Wisconsin; Philadelphia and Washington, D. C.; and Atlanta and Macon, Georgia. However, despite its apparent advantages, coaxial cable must compete economically with conventional multiconductor telephone cable and with carrier telephony, a method whereby some of the pairs of wires in a conventional cable can carry several simultaneous messages. Coaxial cable is advantageous only when the traffic load of calls is heavy and where distances justify the expense of the special terminal apparatus required.

Television

Coaxial cable is now being used regularly for commercial television transmission over short distances primarily within New York City, and has also been used experimentally for long-distance television in preparation for large-scale postwar use. It appears to be the only continuous physical structure now available which can carry over long distances the several thousand kilocycles' band width required for television transmission. Conventional telephone cable repairs have been adapted for television over distances of a few miles, but conventional long-distance telephone cables can carry a band width of only about 50 kilocycles, far short of television's requirements.

Another possible alternative to coaxial cable in television is use of directed ultra high-frequency radio beams relayed periodically by means of radio relay stations located on hilltops or other high structures so that no other intervening hills or structures will intercept the radio beams. The present television broadcasts from the Empire State Building in New York are being relayed at intermediate points for rebroadcast at Schenectady and at Philadelphia. The Bell System has announced a trial of radio relay chain between New York and Boston. If such a system should prove successful and capable of operation at reasonable cost, there is a possibility that radio relays will be used extensively in long-distance intercity communications for both telephone and television transmission.

The practicability of coaxial cable in long-distance television transmission has been successfully demonstrated on existing installations, particularly the Minneapolis - Stevens Point cable whose four coaxial units were looped together to form about an 800 mile circuit. With the New York-Philadelphia coaxial cable a band nearly 3000 kilocycles wide can be made available for television transmission. This was shown in 1940 when the Republican National Convention was televised at Philadelphia and broadcast from the Empire State Building in New York. Future developments now in prospect are expected to permit the transmission of a considerably wider band of frequencies over a single coaxial unit.—From the Arthur D. Little, Inc. Industrial Research Bulletin.

Centrifugal Pump Control*

Part V

Protective controls; what they are, when and why used, how they operate. . . . Automatic by nature. . . . Check valves, protective motor controls. . . . Automatic operation of standby boiler feed pumps. . . . Principles and operation of pump by-passes. . . . Automatic pump by-pass control, flow meter and thermostatic types. . . . Other protective devices, foot valves, surge suppressors, and relief valves

By Igor J. Karassik — *Application Engineer, Worthington Pump & Machinery Corp.*

PROTECTIVE CONTROLS for centrifugal pump installations are usually extremely flexible and, with only minor modifications, can be made to serve most situations.

Protective controls are, by their very nature, automatic in their operation since they serve mainly to complement the operating personnel and perform functions which would normally be performed manually, if the personnel were on hand. Likewise, the majority of these controls are intended to stop the pump and its driver whenever certain harmful operating conditions arise. A few operating controls, on the other hand, provide for some alteration in the operating conditions under the same circumstances.

Most of the reasons which might call for stopping a unit were discussed in an earlier article of this series.† In general, the impulse for the operation of the protective control is selected from the conditions themselves which it is desired to avoid or eliminate. A rather typical case is check valve provided with a switch to operate the electric motor driving a centrifugal pump to protect it against damage caused by loss of water during operation. While the pump is discharging water, the check valve flap is raised and the switch is held closed. If for any reason the flow ceases (due to lack of water at the suction, for instance) the valve flap falls and opens the switch. The latter, being connected into the motor starter circuit, stops the pump automatically, before any damage can occur to the pump from running dry.

Check Valves

Under certain conditions a centrifugal pump may be permitted to operate against a closed valve in its discharge, hence the simple check valve itself is, of course, a protective control device, for it prevents reverse flow through the pump whenever the pump discharge pressure falls below the pressure in the header into which the pump is discharging. At the same time, a pump operating against shut-off will, in most cases, be damaged through overheating, therefore every check valve installation must be checked from this point of view, to assure that shut-off operation cannot take place for any length of time. Wherever such danger exists, a by-pass of some sort is provided, either manually or automatically operated, as discussed below.

Protection against loss of prime, provided by the check valve with switch described above, can also be incorporated into the motor starter itself. In such an arrangement, an inverse current relay is used to interrupt the electric circuit whenever the power consumption, and hence the current input to the motor, falls to say 50 per cent of the minimum value under any of the normal operating conditions. For instance, should the maximum brake-horsepower of the pump be 500 and the minimum (at shut-off) 280 hp, the inverse current relay would stop the pump if the power fell to 140 hp, indicating that the pump has lost its prime and is in imminent danger of running dry. A time relay must, of course, be incorporated in this control, to permit operation of the pump when it is being started.

Motor Controls

Various forms of motor controls which provide for protection against undervoltage, overload, frequency change and other motor conditions are not, strictly speaking, centrifugal pump controls. Motor overload may easily be caused by pump operation conditions, therefore provision must be made for this protection if the relation of the pump and system characteristics are such that driver overload is possible. The most important consideration, however, in the application of motor protective controls is that the operator should know, whenever possible, that a motor has been stopped through the operation of one of these controls. This can be accomplished by the ringing of a bell or the lighting of a signal light. Thus faulty operating conditions may be detected as soon as

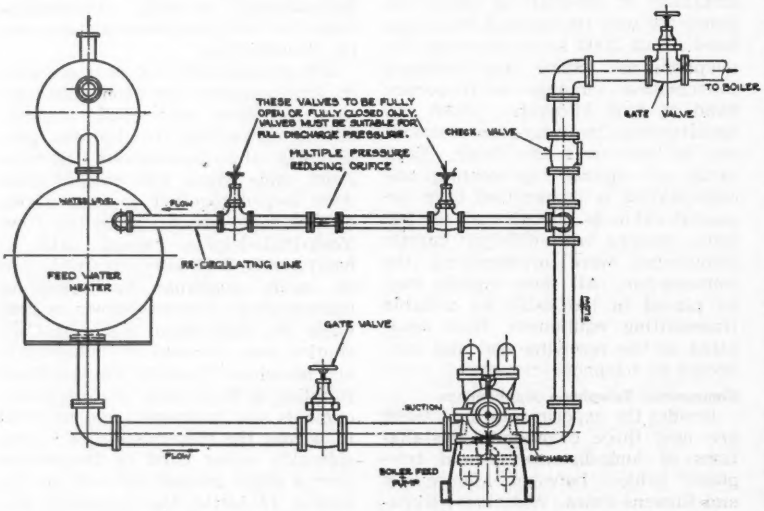


Fig. 1. Boiler feed pump by-pass arrangement

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*Part I, Characteristics of Centrifugal Pumps, December, 1944 issue; Part II, Functions of Centrifugal Pump Control, January, 1945 issue; Part III, Analysis of Control Elements, February, 1945 issue; Part IV, Analysis of Boiler Feed Pump Control, March, 1945 issue. Part VI, to appear in a subsequent issue, will discuss The Technique of Control Application.

†Part II, January, 1945.

they occur and can be corrected immediately.

In many cases, restarting of the driver and its pump upon the resumption of normal conditions is highly desirable and the interrupting device is provided with re-establishment of current features. In other cases, however, as when a pump must be primed manually prior to starting, the contactors must be arranged not to close again until the circuit is reestablished manually by manipulating the starting push-button.

Automatic Operation of Standby Pumps

Another example of a protective device is the automatic operation of standby boiler feed pumps in a power plant. The exact moment of a pump or drive failure is unpredictable and may find the operators at some remote part of the station, unable to attend to the starting of the standby unit without a dangerous delay.

The majority of protective controls for starting standby pumps are based on pressure conditions in the main feedwater header. This header pressure is transmitted to one side of a spring-loaded diaphragm, the minimum permissible header pressure providing the selected value of spring compression. The diaphragm-operated valve is held closed as long as the header pressure exceeds the predetermined minimum. If the header pressure falls below this value, the valve opens. This valve is generally used as a pilot valve and, in turn, may be made to operate any suitable mechanism which will start one or more of the standby units.

Whenever a standby unit is arranged for automatic starting through some control as described above, it must be held in condition to do so without any further manual operation. For instance, in the case of boiler feed pumps, both suction and discharge valves must be open at all times, the pump remaining protected against reverse flow by its check valve. All service lines, such as water cooling supply to the bearings or stuffing boxes must be open or, at least, arranged to open automatically upon the starting of the unit.

Why The Automatic Boiler Feed Pump By-Pass?

Although the automatic operation of a boiler feed pump by-pass is not at present a very common application, it is a typical example of a form of protective control which will see more widespread use in the future. While the necessity of a by-pass to protect the boiler feed pump at low flows has been discussed in several articles within the last five years, it may be advisable, for a more complete understanding of the application of the automatic by-pass control, to describe the phenomena taking place in a centrifugal pump under various conditions of operation.

The difference between the brake-horsepower consumed by the centrifugal pump and the water horsepower developed represents the power losses

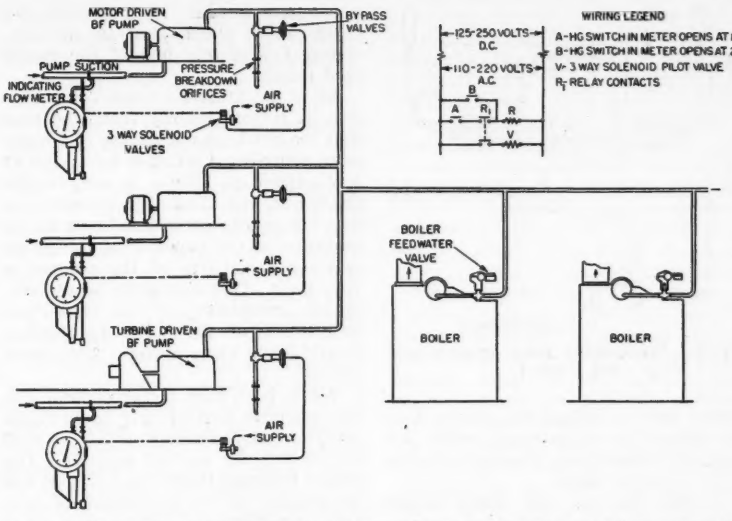

Fig. 2. Diagrammatic arrangement of automatic pump by-pass controls on three feed pumps in parallel. (Courtesy Bailey Meter Co.)

within the pump itself, all these power losses being ultimately transformed into heat.

Theoretically it would be necessary to deduct from these losses both the bearing losses and the loss of heat through radiation. But for practical purposes it is accurate enough to assume that all the heat is made available and recoverable in the water passing through the pump. The actual amount of temperature rise at any given operating condition on the centrifugal pump can, therefore, be easily determined by multiplying the horsepower loss by 2545 (the Btu equivalent of one horsepower-hour) and dividing this total heat imparted to the water by the corresponding flow in pounds per hour.

Obviously, the losses at low delivery are greater than at high capacities. Inasmuch as the total flow that absorbs the developed heat is low, the temperature rise increases very rapidly with decrease of flow.

Effects of Temperature Rise in Pump

Boiler feed pumps are generally called upon to operate in a very wide load range, all the way from practically shut-off to full load. The problems in the operation of a feed pump at light loads are extremely important and must be treated with this in mind. It is almost common knowledge that a pump operated at shut-off would soon over-heat and seize. Specifically, the various effects of an excessive temperature rise in a boiler feed pump are as follows:

1. Excessive expansion at the running joints and ultimate binding and seizing of adjacent parts of the pump, which are designed to operate with a definite clearance;

2. Ultimate decrease in the pressure margin over flashing in the first stage impellers and subsequent cavitation and vapor binding;

3. If the pump incorporates a balancing device, the vapor pressure of the overheated water in the relief chamber at the exit from the balancing device may rise above the pressure existing therein, with consequent flashing in the relief chamber and possibly even in the balancing disc itself.

All these effects unite to shorten the life of the various component parts of the boiler feed pump if allowed to be carried to an extreme. Therefore, to protect the pump from the damage incidental to an excessive temperature rise, precaution must be taken to avoid operation of the pump at abnormally low flows. Inasmuch as the capacity of the boiler feed pump is solely governed by the feedwater regulator, which in turn is controlled by the main turbine load and the resulting rise or fall of the boiler level, some specific means must be applied to maintain predetermined minimum flow through the boiler feed pump regardless of the turbine load.

This is achieved by installing in the discharge line from the boiler feed pump a by-pass located on the pump side of the discharge gate valve and check valve and leading to some region of lower pressure in the boiler feed cycle. The capacity of the by-pass is such that if the demand at the boiler falls to zero or if one of the valves becomes closed while the pump is running at full speed, the flow through the pump will not fall below the predetermined permissible minimum. This minimum is generally based on a maximum temperature rise of 15F. This corresponds to approximately 30 gpm for every 100 bhp at shut-off conditions. The operation of the by-pass is then regulated by means of a valve, controlled either manually or automatically.

Generally an arrangement such as shown in Fig. 1 is used. Two valves are installed, one on each side of the orifice which controls the actual capacity in the by-pass. One of these valves remains always open and is

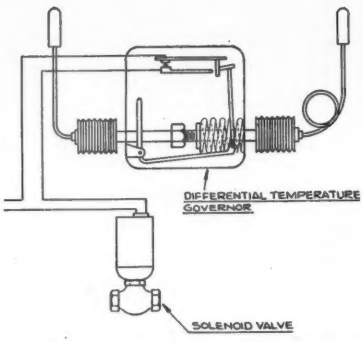

Fig. 3. Thermostatic pump by-pass control, Type I

closed only to isolate the orifice during inspection or renewal while the pump is in operation. The second valve is the control valve.

Within the last few years power plant operators have indicated a growing interest in automatic control of the by-pass, especially in high-pressure installations, where the trend is towards automatic control of all the phases of operation.

Arrangement of Automatic By-Pass

Automatic control of the by-pass involves some sort of actuating mechism that will open and close the by-pass at the proper time. The actuating mechanism itself must be subjected to an impulse governed by the flow through the boiler feed pump, a great number of impulses being available for this purpose, as follows:

1. Pressure drop across the feedwater regulator. This drop is a function of the flow, therefore it has a definite value at the capacity at which it has been determined that the by-pass must be opened. Such a system will not apply, of course, when the feedwater regulator control is of such a nature that the pressure drop across the regulator is constant at all flows.

2. Position of the feedwater regulator. The by-pass valve mechanism can be linked to the regulator mechanism in such a manner that the closing or opening of the regulator valve would be transmitted to the by-pass valve.

3. Relief valve operated by the discharge pressure of the pump. Inasmuch as the discharge pressure of a given centrifugal pump is a definite function of its capacity, the opening or closing of the by-pass valve may be based on a maximum and minimum setting of the pressure relief valve.

4. Flow meter control in the suction or discharge line.

5. Thermostatic control.

Which Type To Use

From an evaluation of the respective advantages and disadvantages of these five sources of impulse, it appears that flow meter or thermostatic controls are by far the safest and most reliable of the five. The main disadvantages of the first two is that they afford no protection when several pumps are operated in parallel, discharging into a common header, in the event the check valve slams shut in the discharge line of any one of the boiler feed pumps.

As to the pressure relief valve control, it suffers mainly from the fact that the head-capacity curve of a high-head centrifugal pump is fairly flat at low capacities. Thus, a very slight change in the discharge pressure in that range may correspond to a major variation in the capacity of the pump and the sensitivity of the control is very poor. This sensitivity would disappear completely, if the characteristic curve of the boiler feed pump should have even a slight drop near shutoff.

While both flow meter control and thermostatic control have some slight inherent shortcomings, either is well suited for the desired purpose. The choice between these two methods lies principally in the preference of control manufacturers and power plant operators. Before describing a few typical arrangements of such controls, here are some of the factors that may affect the choice between the two impulses.

In some instances, there may be a very low net positive suction head available at the boiler feed pump suction, so that if the orifice used to measure the flow induces an appreciable pressure drop, flashing might occur under certain operating conditions. Hence, it may be necessary to consider the possibility of using a flow meter with very low pressure drop. However, the point of by-pass being at a very low meter capacity, the power available for operation of the meter is very low, so that it is not advisable to use a flow meter with too low a pressure drop.

When the installation under consideration provides a very low static head on the suction of the pump, it then becomes necessary to move the orifice to the discharge side of the pump. In this position, however, the orifice operates under high pressure, and it is necessary to design the flow meter for the higher pressure involved. In addition, this method cannot be used without calibrating the control for every single installation.

The thermostatic control has none of these disadvantages. Inasmuch as the value of maximum permissible temperature rise is established empirically and is limited to a range between 15 and 20F, it is possible to arrange a mechanism which will measure the temperature differential between the inlet and outlet of the pump and which need not be calibrated for every single pump to which it is applied. Nor will the actual temperature of operation affect this mechanism, inasmuch as temperature differences rather than actual values of temperature are being measured.

Not the least of the advantages of thermostatic control resides in the fact that it becomes most accurate in the range of its greatest need, i.e., the greatest temperature difference and hence greatest accuracy occurs at light loads.

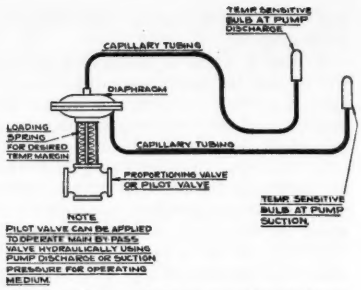
TEMP SENSITIVE BULB AT PUMP DISCHARGE
CAPILLARY TUBING
DIAPHRAGM
LOADING SPRING FOR DESIRED TEMP MARGIN
CAPILLARY TUBING
PROPORTIONING VALVE OR PILOT VALVE
TEMP SENSITIVE BULB AT PUMP SUCTION
NOTE
PILOT VALVE CAN BE APPLIED TO OPERATE MAIN BY-PASS VALVE HYDRAULICALLY USING PUMP DISCHARGE OR SUCTION PRESSURE FOR OPERATING MEDIUM

Fig. 4. Thermostatic pump by-pass control, Type II

On the other hand, the thermostatic control presents certain mechanical difficulties in that the thermo-couple or thermometer (whichever may be used) must be introduced into the discharge of the boiler feed pump and is therefore subjected to the full discharge pressure. This imposes certain strength requirements which work to the detriment of greater sensibility and introduces a greater time-lag, because the necessary reinforcement absorbs heat before the measuring element can register temperature change.

This time-lag factor in itself is almost non-existent in the case of flow meter control, therefore it must be reduced to an absolute minimum through special construction of the temperature measuring element if the thermostatic control is not to suffer from an excessive lag which would erase all of its advantages.

Flow Meter By-Pass Control

The actual operation of the flow meter control as shown in Fig. 2 is quite simple. A flow meter element is located in the pump suction line. The meter operates two mercury switches. The contacts are so adjusted that the first contact completes the circuit on a decreasing flow but permits no by-pass until the second contact has been made at a still lower flow. This provides an overlap to prevent hunting, for the interval between the two contacts exceeds the amount of the by-pass flow and the circuit is not broken until the total flow has increased to a value above the point of the first contact. The circuit is made to operate a solenoid valve admitting air pressure to the control diaphragm of the by-pass valve itself.

The circuit can be arranged so that the relay controlling the air loading pressure to the by-pass valve is de-energized at the low flow conditions, so that the by-pass would be operated in case of a failure of electric power to the contacts as well as at reduced flows. Similarly, since the by-pass valve is kept closed by air pressure, a failure of air pressure will also operate the by-pass and the boiler feed pump is protected against damage under all conditions.

Another variation of the flow meter control consists of actuating the by-pass valve by means of a spring-loaded

diaphragm. This operates in conjunction with a flow meter orifice in the discharge line. The diaphragm is so calibrated that the by-pass valve will begin to open when the pump discharge capacity corresponds to the permissible minimum and gradually increases the opening to a maximum at zero discharge flow. A certain disadvantage of this variation resides in the fact that a valve wears out much faster in a throttling operation than if it is either fully open or fully closed.

Thermostatic Control (Type I)

Thermostatic control of the by-pass can be actuated by a differential temperature governor and a solenoid operated valve as shown in Fig. 3. The temperature governor consists of two identical bellows connected so that when pressure is applied, their forces act in opposition. Pressure is obtained from temperature sensitive bulbs, connected to the bellows through capillary tubing. If the bulbs are exposed to identical temperatures, the forces of the two bellows balance. If one bulb is exposed to a higher temperature than the other, a differential pressure results which is utilized to operate an electric switch.

The switch is a "snap-action" device, which remains open or closed until some definite, predetermined force is applied, at which time it is closed or opened quickly. In this application, an increase in the differential temperature to, for example 15F would cause the switch contacts to close. A reduction in the differential temperature to 5 deg would cause the switch to open.

The valve illustrated in Fig. 3, is operated by an electric solenoid, opposed by a spring. When the solenoid is energized by closing the differential temperature governor, the valve can be either opened or closed. When the solenoid is de-energized the valve takes the opposite position. For safety reasons it is recommended that the valve open when the solenoid is de-energized so that in case of accidental power failure, the by-pass will be open rather than closed.

The solenoid valve is used for illustration only. Other electrically controlled types can be used with equal facility, as for instance hydraulically or pneumatically operated valves with electrically-controlled pilot circuits.

Thermostatic Control (Type II)

The desired control for the by-pass valve may be obtained by means of a spring loaded diaphragm valve as illustrated in Fig. 4. Two temperature sensitive bulbs are used to measure the temperature at the pump suction and the pump discharge respectively. These bulbs and the connecting tubing are filled with a liquid or gas of such nature that temperature changes at the bulb cause changes in the internal fluid pressure proportional to the temperature changes. One side of the diaphragm is loaded with the fluid pressure corresponding to the temperature at the discharge, while the other side is subjected to the fluid pressure corresponding to the suction temperature. The desired maximum temperature margin between these two temperatures determines the size and tension (or compression) of the loading spring.

As soon as the discharge temperature becomes equal to or greater than the sum of the suction temperature and the desired margin, the equilibrium of loading is changed and the valve opens. This valve can be used either directly in the case of limited size installations or as a pilot valve controlling a larger size proportioning valve by means of air, water or oil pressure.

Of course, by-pass controls are not necessarily restricted to application in boiler feed pump installations, since they perform as important a function in any installation of centrifugal pumps where the system cycle is such as to introduce the possibility of operation at extremely reduced flows or against a completely closed discharge. However, it must be considered that when light-flow operation occurs at extremely frequent intervals, as in a steel mill descaling installation, it may be more practical to maintain the by-pass valve constantly in the open position or to provide a three-way valve, so that when the main flow is shut off, the by-pass flow is automatically established.

Other Pump Protective Controls

The use of check valves in the pump discharge to prevent reverse flow in the pumping system has already been mentioned. The application of foot-valves to pumps operating with a suction lift clearly belongs in the same class of protective pump controls, although it serves the additional duty of retaining water in the pump casing and thus allowing the pump to remain primed at all times.

However, ordinary check valves have the inherent characteristic of closing very quickly and therefore may give rise to excessive pressures in the system through the creation of water hammer. It is therefore desirable in certain cases to install slow closing power operated valves, such as cone valves or butterfly valves. These valves are generally hydraulically or even pneumatically operated, using either the hydraulic pressure in the pumping system itself or on external source of liquid or air under pressure for the source of power.

These protective controls can be applied not only to prevent reverse flow but also they protect the system against situations arising from the rupture of the pumping line, preventing loss of pumped fluid. This function is performed by making the valve control responsive to excessive velocities in one direction only or in either direction, depending on the particular features of the installation.

Another protective device used to stop reverse flow through a pump under certain conditions is the automatic syphon breaker. It may be applied to systems where the pump discharges into a syphon system and where power failure and the resulting stopping of the pump would be followed by the loss of water from the discharge reservoir through the syphon, unless the action of the latter was interrupted. The syphon breaker valve is located at the top of the syphon and maintained in a closed position by means of an energized solenoid. Power failure de-energizes the solenoid and opens the valve, admitting air into the system and breaking the syphon action.

Relief Valves

There are a few pumping systems which may become subject to excessive

(Continued on page 124)

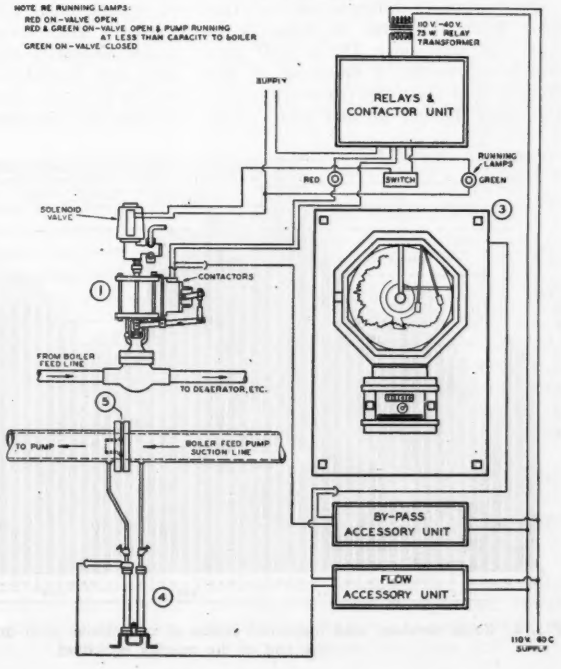

Fig. 5. Details of pump by-pass control equipment, controlled by flow meter. 1—By-pass valve; 3—2-pen recorder, recording flow through pump and by-pass separately; 4—meter body; 5—orifice in pump suction line; contactors, relays and accessories as noted.

(Courtesy, Republic Flow Meters Co.)

Store Coal for Next Winter—NOW

By RALPH E. TURNER
Editor
Power Plant Engineering

Country's stocks of bituminous coal are dwindling, general decline since 1942—Production this calendar year nearly 17,000,000 tons less than in 1944—Labor difficulties have forced Government operation—Government directives aimed at fair distribution—Fuel use efficiency advanced by work of National Fuel Efficiency Program—Government is encouraging summer coal storage but is limiting permitted amounts—Medium and small power plants need modernization and improved efficiency

THIS NATION went through last winter on such a small margin of coal in stock that scarcely a week went by without some warning or directive from the Government aimed at reducing fuel use for nearly all purposes. The feeling of an impending shortage of fuel for heating and power production is anything but comfortable and right now is the time to make plans for building up a reserve supply of fuel estimated to carry the nation through all contingencies that may arrive next winter.

As it exists today the situation is none too encouraging. The country's stocks of bituminous coal and lignite are about where they were in the peace time months of early 1941. Reserves were highest in the late months of 1942, nearly twice what they are today, but the trend has been downward since then with the exception of a seasonal rise during the summer months of 1944. A national crisis was averted last winter largely through co-ordinated and co-operative efforts of coal users, coal haulers, the coal miners and mining industry, all looking to the Solid Fuels Administration for War for directives designed to insure fair distribution.

Production of bituminous coal this year from the first of January to April 21 was only 182,011,000 tons which represents a decrease of 16,961,000 tons from the production over the same period of last year. This loss in production cannot be made up during the next few months because reduced manpower in the mines is limiting output. Drawn out contract negotations between operators and mine workers are, at the time of this writing, interfering with full scale production of both bituminous coal and anthracite with the Government taking over operation of mines as seems necessary to keep production as nearly up to capacity as possible.

Transportation facilities are now and will continue to be crowded as long as the war continues. And even following the war, reconversion, new construction and other industrial activities will demand railway service that might otherwise be used for fuel transportation.

Particularly aggravating last winter were the severe weather conditions which nobody could control. Deep snow almost completely isolated some sections of the country. Ice in rivers interferred with boat transportation. Conditions of this sort caused reduction in production of as much as 600,000 tons in one week.

With consumption exceeding production, as it has been since the first of the calendar year, it is imperative that everybody concerned do his best to decrease the threatening coal deficit—the coal users by burning coal more efficiently and using power and heat less wastefully, and mine workers by reducing absenteeism. Any production lost because of a lack of summer orders will be sorely missed next winter, as mines are not operated unless they have orders for coal.

Labor difficulties in the coal mining industry have for years handicapped production, and many times have become so severe that the Government has been asked by labor elements or the operators to take over operation and maintain order at mining properties. This has been done temporarily in many instances, the property being handed back to the owners when controversies have been settled. This spring the "take-over" move has apparently entered another phase of procedure, in that the Government has assumed the initiative not necessarily in the job of protecting mine property and the interests of workmen but primarily to protect the fuel consuming public against a fuel shortage next winter by using the force of

Stocks and Consumption of Bituminous Coal and Lignite in the United States, Including Retail Yards

	March 1945 (preliminary)	February 1945 (revised)
Stocks, End of Month, at:	Net tons	
Electric power utilities	12,519,000	12,916,000
Byproduct coke ovens	5,452,000	5,610,000
Steel and rolling mills	725,000	666,000
Coal-gas retorts	175,000	189,000
Cement mills	441,000	448,000
Other industrials	12,562,000	12,625,000
Railroads (Class I)	9,964,000	10,189,000
Total industrial stocks	41,838,000	42,643,000
Retail dealer stocks	3,656,000	3,130,000
Grand total	45,494,000	45,773,000
	Total by months	
Monthly Consumption by:	Net tons	
Electric power utilities	6,186,000	6,210,000
Byproduct coke ovens	8,060,000	7,216,000
Beehive coke ovens	819,000	708,000
Steel and rolling mills	938,000	942,000
Coal-gas retorts	138,000	133,000
Cement mills	265,000	245,000
Other industrials	11,760,000	12,049,000
Railroads (Class I)	11,411,000	10,749,000
Total industrial	39,577,000	38,252,000
Retail dealer deliveries	12,110,000	14,297,000
Grand total	51,687,000	52,549,000
Additional Known Consumption:		
Coal mine fuel	239,000	214,000
Days' Supply, End of Month at:	Days' supply	
Electric power utilities	63 days	58 days
Byproduct coke ovens	21 days	22 days
Steel and rolling mills	24 days	20 days
Coal-gas retorts	39 days	40 days
Cement mills	52 days	51 days
Other industrials	33 days	29 days
Railroads (Class I)	27 days	27 days
Total industrial	33 days	31 days
Retail dealer	9 days	6 days
Grand total	27 days	24 days

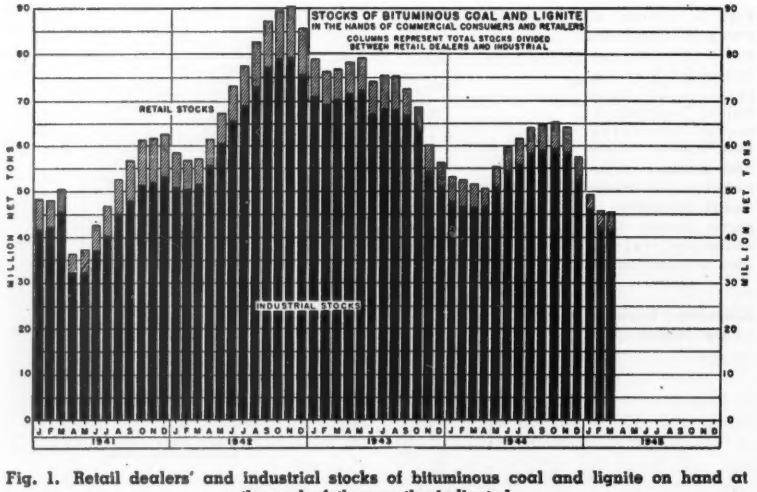
STOCKS OF BITUMINOUS COAL AND LIGNITE IN THE HANDS OF COMMERCIAL CONSUMERS AND RETAILERS
COLUMNS REPRESENT TOTAL STOCKS DIVIDED BETWEEN RETAIL DEALERS AND INDUSTRIAL
RETAIL STOCKS
INDUSTRIAL STOCKS
MILLION NET TONS
J F M A M J J A S O N D
1941
1942
1943
1944
1945

Fig. 1. Retail dealers' and industrial stocks of bituminous coal and lignite on hand at the end of the months indicated

the Government to compel continuous operation of the mines at the fullest possible capacity, particularly during the summer months when the transportation and storage of coal is most conveniently carried out.

For example, on May 4 the public was informed that for the third time since Pearl Harbor was attacked, the United States Government took possession of the strike-bound Pennsylvania anthracite mines and breakers because a breakdown in wage negotiations threatened a fuel crisis that would impair public health and impede the progress of the war next winter.

In taking over the facilities of 363 Pennsylvania anthracite companies, Secretary of Interior Harold L. Ickes called on all mine, breaker and other employes to return to work immediately, and designated the operating heads of the coal companies as Federal Operating Managers to maintain continuous full operations under Federal possession. These managers were instructed to operate the mines for the financial account and at the risk of the owners but subject to the orders of the Solid Fuels Administration for War.

A similar announcement was made on May 5 of the Government's action in taking possession of 33 bituminous coal mines which had remained idle since April 30 because the mine employes failed to go back to work under the new Government approved contract executed between the United Mine Workers of America and the mine owners. This take-over order increased to 272 the number of soft coal mines at that time in Government possession because of strikes following the expiration of the old mine wage agreement on March 31.

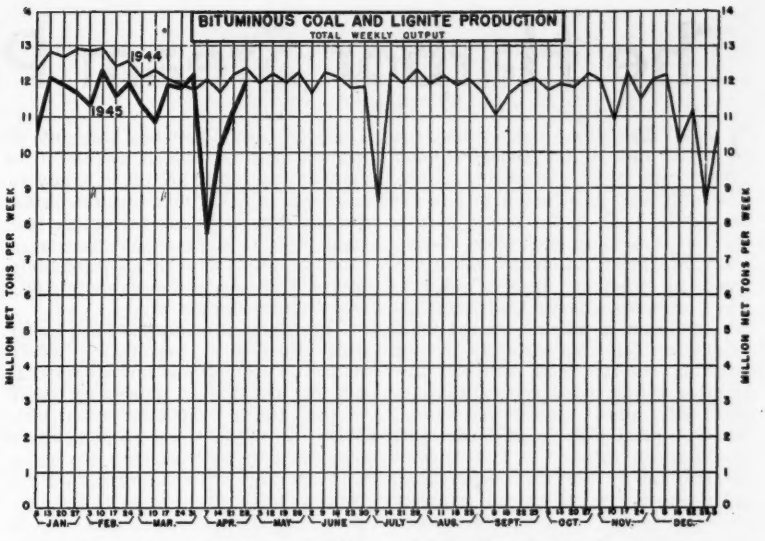

Fig. 2. Curves showing weekly coal productions for 1944 and '45

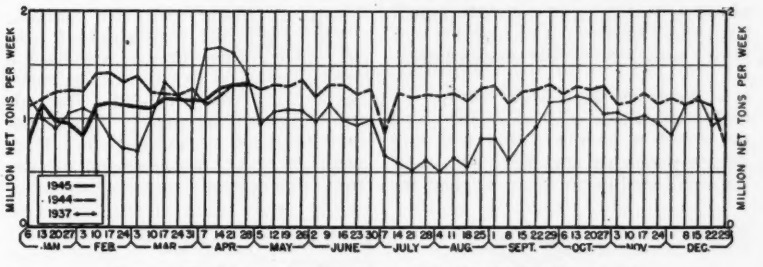

Fig. 3. Weekly production of anthracite for 1937, '44 and '45

Movement of Coal

In the movement and distribution of fuel, the Government has been equally active and effective. Totals and averages regarding fuel deliveries to various sections of the country have been watched with extreme care to make certain that a fair share is made available to individual users. The needs of consumers in the Upper Great Lakes regions, where most coal is delivered by means of boats, for example, were estimated and efforts made to transport this fuel during the open season and have a sufficient supply on hand locally to last through the winter without additional delivery. In the New England region delivery is principally by rail although some comes in by ocean going vessels which operate during winter as well as summer. Anticipating severe winter weather, the attempt is made to have the peak of movements to this section take place during the fall months although deliveries are made during the entire year.

In the latest report on coal shipment, dated April 26, it is stated that bituminous coal forwarded to New England from April 1 to 14 was 828,233 tons which is 7.1 per cent below the total moved to the area in the comparable period last year. Anthracite shipments to this area, 241,175 tons, were about 0.6 per cent lower than last year for the first two weeks in April.

Coal forwarded to the Washington-Oregon area from mines in the Rocky Mountain producing districts approximated 46,890 tons in the week ending April 14 and 58,860 the previous week, the total being a decrease of 11,835 tons from the comparable period of 1944.

During the first two weeks of the present coal year, which began April 1, coal forwarded via water from the lower Great Lakes loading ports amounted to 1,422,527 tons which is considerably less than forwardings of last year.

These figures are typical of what is taking place throughout the country. Production is down and forwardings to all areas suffer. Under Government direction, however, the supply is being distributed as equitably as reasonably possible.

Warnings and Directives

To impress the importance of saving fuel upon fuel users, miners, mine operators, coal dealers and the public in general, many warnings and directives, of which the following are typical, have been issued by the SFAW:

On January 12 reductions were ordered in shipments of Illinois and Western Kentucky coal to industries having more than 20 days' supply on hand. "Shortages in eastern-mined coals for household use, as well as greater industrial activity, make midwestern consumers increasingly dependent upon supplies from Illinois, Western Kentucky and Indiana fields," said C. J. Potter, deputy solid fuels administrator.

Shipments of high volatile soft coal from mining District No. 8 in all sizes commonly sold at retail were banned on January 16 to retail dealers in Illinois, Iowa, Minnesota, Nebraska, North and South Dakota, Wisconsin and Missouri. Sizes used as stoker fuel were exempt from the order.

Because of transportation difficulties due to bad weather, requests were made on January 10 that producers in two Southern Appalachian mining districts refrain from shipping more coal into the area west of Pittsburgh and north of central Ohio, Indiana and Illinois until January 15.

Utilities Order U-9, commonly known as the "brownout" order, became effective on February 1 and virtually eliminated use of electricity for outdoor advertising, ornamental and display lighting. This order was estimated to save coal at the rate of 2,000,000 tons per year.

On January 26 an order was issued to retail dealers in specified areas forbidding delivery of solid fuels to

(Continued on page 122)

The Harbor Steam Plant Boiler

TWO YEARS have passed since the boiler unit of the Harbor Steam Plant* was first placed in service. This unit was constructed to operate in parallel with hydro power plants, that is as a base load plant during years of deficiency in hydro energy on down to "spinning reserve" during years of hydro plenty. Under the latter condition it may be called upon to pick up full load instantly from a spinning reserve load of 5,000 kw. In other words, it is a general purpose plant with added special characteristics for quick pick-up of load. The heavy power demand in Los Angeles brought on by the war required almost continuous full load capacity output since the plant was first placed in operation. It was only during the latter part of 1944 that the quick pick-up tests could be attempted without endangering reliability of power supply to the Los Angeles area.

Design for Quick Load Pick-Up

The quick load pick-up requirement presented a number of interesting design problems for the boiler unit. As mentioned in previous articles* the Harbor Steam Plant has built into it certain features which enable it to function as a standby plant, ready to take over a power load of up to 65,000 kw with no previous warning. The plant was to float on the line at a standby load of only approximately 5000 kw, requiring approximately 60,000 lbs of steam per hr.

The specifications called for a boiler unit capable of performing safely under the continuous low steam output but capable of delivering steam at the rate of 675,000 lb per hr, this steam demand coming on instantaneously and without warning. No boiler unit had ever been constructed for steam load pick-ups even closely approaching these requirements. To illustrate the expected changes taking place in the boiler during an instantaneous extreme load rise starting with the standby steam output rate of 60,000 lb per hr and reaching a peak of 690,000 lb per hr, the curve sheet Fig. 3 was prepared. The values indicated are purely theoretical and the result of calculations. They were, however, the basis for the design of the steam generating unit.

Contrary to usual practice, the automatic control equipment is arranged to maintain a constant boiler drum pressure rather than a constant header pressure beyond the superheater. This arrangement was selected to have highest possible drum pressure available at the moment of load pick-up. An instantaneous rise in steam demand not only lowers drum pressure while steam is flashed from boiler water, but also results in high friction loss in superheater and piping to turbine. By keeping the drum pressure as high as possible during standby operation, the available pressure head insures that the turbine throttle pressure need not drop below 800 psig at the moment of load pick-up.

Some of the Major Problems

Problem 1:—It could not be expected that fuel burning rate and the heat release in the furnace would increase simultaneously with the sudden rise in steam demand. A time lag of possibly 25 sec had to be assumed for fans to speed up and for the burners to reach maximum oil burning rate. During this time, all steam delivered by the boiler above the initial rate of 60,000 lb per hr must flash from boiler water while the boiler pressure drops. The boiler must perform as a steam accumulator. It was calculated that a drop in boiler pressure from 1050 psig to 937 psig during the 25 sec period would deliver steam at the rate of 630,000 lb per hr by flashing from 3500 cu ft boiler water.

A boiler unit of comparable capacity with the Los Angeles unit would normally contain approximately 2,200 cu ft below the working water line. It was necessary to install unusually large submerged drums to provide for 3500 cu ft water

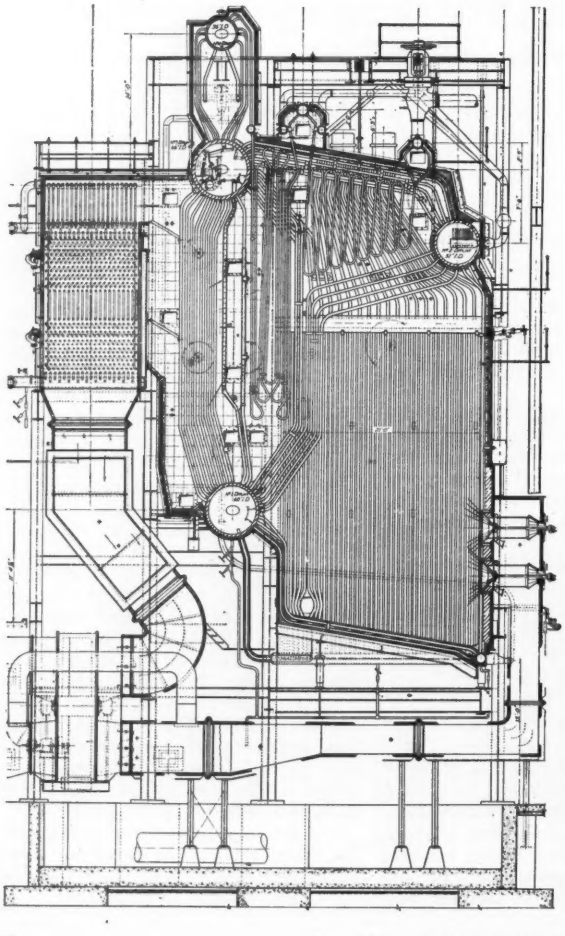

Fig. 1. Cross-section through Harbor Steam Plant boiler

BOILER DATA

The boiler unit is designed for 570,000 lb per hr continuous steam output rate, 915 F steam temperature from feedwater of approximately 390 F temperature. Because the boiler drum pressure is maintained constant at 1040 psig, the superheater outlet pressure varies with the load and is approximately 916 psig at the 675,000 lb. per hr maximum steam output.

The oil-fired furnace has 22,500 cu ft effective volume, resulting in 37,800 Btu per cu ft furnace heat release rate at 675,000 lb per hr steam output rate. The furnace is equipped with 10 wide range oil burners.

The superheater is of the vertical loop type. Steam temperature control is automatic. Part of the steam, after it is heated to approximately 750 F, is passed through cooling tubes submerged in boiler water of the 51-in. diameter front drum.

The steam is cooled to within a few degrees of boiler water temperature. Cooled steam re-enters the intermediate superheater header where it is mixed with the partly superheated steam before entering the high temperature section of the superheater. The flow of cooling steam is automatically controlled by the final steam temperature, which is maintained constant above 300,000 lb per hr steam output.

Furnace water wall surface is 6800 sq ft. and the effective boiler heating surface is 24,100 sq ft.

The heat recovery equipment beyond the boiler consists of a 12,000 sq ft bare-tube economizer and two regenerative air heaters of 66,300 sq ft combined heating surface.

By M. H. Kuhner

Chief Mechanical Engineer
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Details of quick steam load pick-up and normal operating tests on steam generating unit No. 1, Harbor Steam Plant, Department of Water & Power, City of Los Angeles, California. . . . Problems in design of unit to pick up load from 60,000 lb per hr to 690,000 lb per hr instantaneously. . . . Comparison of calculated pick-up conditions with actual conditions. . . . Unit has overall thermal efficiency of over 87 per cent at full load. . . . Station heat rate 10,939 Btu per kw hr net station output at 62,846 kw load.

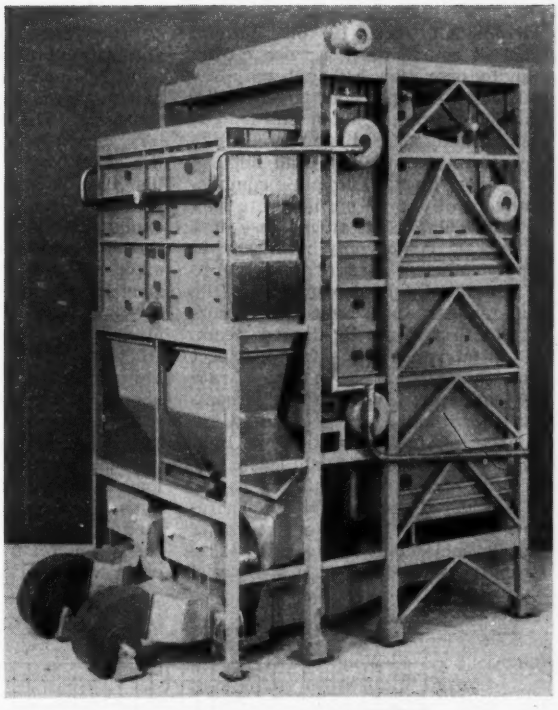

Fig. 2. Scale model of complete steam generating unit

storage. The bottom drum is 60 in. I. D. and the submerged front drum, which contains the steam cooling tubes of the superheat control, is 51 in. I. D.

Swell

Problem 2.—The severe drop in boiler pressure was expected to produce considerable "swell" of the boiler water. The calculations indicated that the sudden formation of steam under water would momentarily increase the volume below the water level by 140 cu ft. The steam release drum was made 66 in. I. D., 45 ft long, so that the "swell" would result in only 7 in. water level rise.

Problem 3:—During normal operation almost all steam formed is released above the water line, because all steam-carrying tubes enter the steam release drum above the working water level. It was realized that during the quick load pick-up, part of the steam formed by flashing would have to find its way through the body of water contained in the drum. The resulting turbulence and geysering in the drum would produce wet steam. A 36-in. I. D. steam drum was placed 15 ft above the normal water level. Steam scrubbing elements are installed in the 66-in. I. D. main drum, while the final steam drying cartons are contained in the 36-in. I. D. steam drum. This drum is drained by gravity to the lowest point of the water wall system.

Circulation

Problem 4:—During standby load with the boiler producing 60,000 lb of steam per hour the circulation of water through boiler and water walls is naturally at a comparatively low velocity; 160,000 lb of water is circulating through the system at somewhat below 2 fps average velocity. The sudden formation of steam under water during quick pick-up and until the higher firing rate is established will further retard the circulation velocity.

To prevent stopping or reversal of flow in boiler and water wall tubes, the circulatory system was arranged for easy, most direct flow of water and steam. Abrupt changes in cross-sectional area were prevented. Full use is made of the fly wheel effect of 80 tons of water circulating through the system, and, in spite of the severe disturbance created by the quick load pick-up, there is assurance that unidirectional flow of water and steam is maintained.

Problem 5:—Rapid temperature changes in water, steam, air and combustion gas had to be considered. Feedwater inlets of the main drum are designed to prevent direct contact of lower temperature feedwater with any part of feed nozzles and drum. Each individual superheater loop is top-supported and free to expand. The high temperature joints of superheater elements and outlet header are welded.

The entire pressure system of boiler and water walls is suspended from overhead structural steel in such a manner that drums, tubes and headers can expand vertically and laterally without producing strains and stresses at points of supports and joints. The fact that the unit had to be built to withstand seismic disturbances injected future problems into the design of suspension and anchoring of the pressure parts.

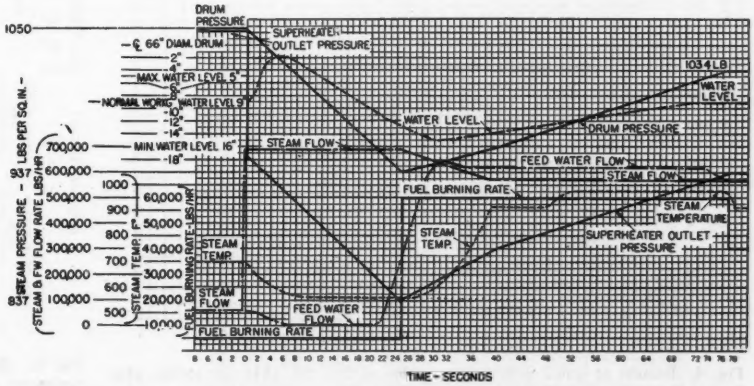

Fig. 3. Expected performance of steam generating unit during instantaneous load pick-up

* Some Features of the Harbor Steam Plant, by W. C. Rowse; Mechanical Engineering, November, 1942.

Harbor Steam Plant Goes on the Line, by C. P. Garman and W. C. Rowse; POWER PLANT ENGINEERING, June, 1943.

Quick Pick-Up, Economy at Harbor Plant, by C. P. Garman; Electrical West, October, 1943.

The Spinning Turbine on Power Systems, by A. G. Christie; POWER PLANT ENGINEERING, January, 1944.

Details of 65,000 Kw Harbor Steam Plant Turbine, by C. C. Frank; POWER PLANT ENGINEERING, February, 1945.

Figures 2 and 6 courtesy Department of Water and Power, City of Los Angeles, Calif.

Combustion

Problem 6:—All 10 oil burners must of course be in service during standby operation, although only 60,000 lb of steam per hour is generated. The oil consumption for this load is approximately 4300 lb per hr. But 25 sec after the first high load impulse is received by the automatic combustion control, the oil burning rate may be 60,000 lb per hr, an increase of 1 to 14! It is not only necessary to supply sufficient heat for the steam to be generated, but also to replace the heat removed from boiler water during the first 25 sec by flashed steam.

It would not be safe to expect that the rapid rise in firing rate will in every instance be accomplished without some temporary unbalance of fuel-air ratio. A light furnace explosion or at least momentary high furnace pressure had to be considered as a possibility. Therefore the entire setting of the boiler unit is enclosed in a steel jacket so strongly reinforced that it will resist internal pressures up to 100 lb per sq ft without permanent deflection and without developing gas and air leaks. Minor furnace explosions will have no serious effects on the setting structure. There is, of course, a battery of explosion doors installed on the boiler roof. Their aggregate relief area is approximately 55 sq ft. It is not wise, however to depend on explosion doors for protecting the setting against damage in case of an explosion. A strongly reinforced steel shell is safer.

Problem 7:—With the steam generating unit designed for 85.5 per cent efficiency at 675,000 lb per hr steaming rate, when burning oil containing about 10 per cent H_2, the final gas temperature at air heater exit is normally far below the point at which condensation occurs when the steam load is only 60,000 lb per hr. An air bypass is provided to deliver the air directly from the forced draft fans to the downstream side of the air heaters. Automatically controlled air dampers regulate the air flow around the air heaters to maintain 300 F minimum exit gas temperature during low standby loads.

Quick Load Pick-Up Tests

While the probability of failure of normal power supply to the system of the City of Los Angeles is remote, it is nevertheless a constant possibility. A breakdown may happen when least expected. Rather than await the instant of such breakdown to find how the Harbor Steam Plant would perform under the resulting quick load pick-up, it was decided to perform a series of quick pick-up tests which were to simulate as far as possible the conditions of an actual break in the power supply system. These tests were conducted not only to familiarize the Station operators and to have them gain experience with the equipment under quick pick-up, but also to check the behavior of main and auxiliary equipment such as boiler unit, turbine generator, fuel system, feedwater system, heaters

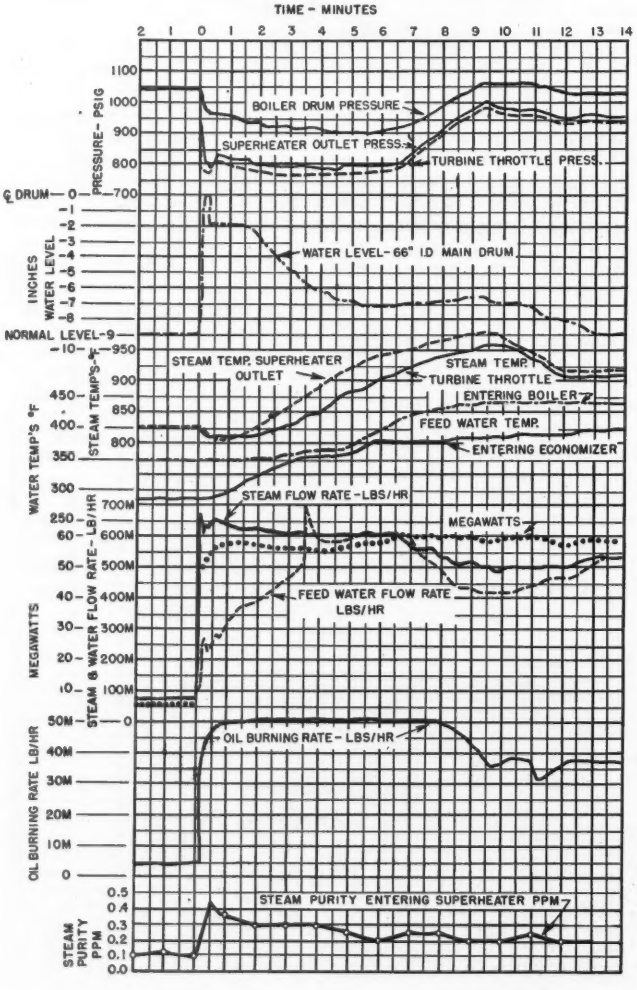

Fig. 4. Results of quick pick-up load tests of Oct. 12, 1944, on steam generating Unit No. 1

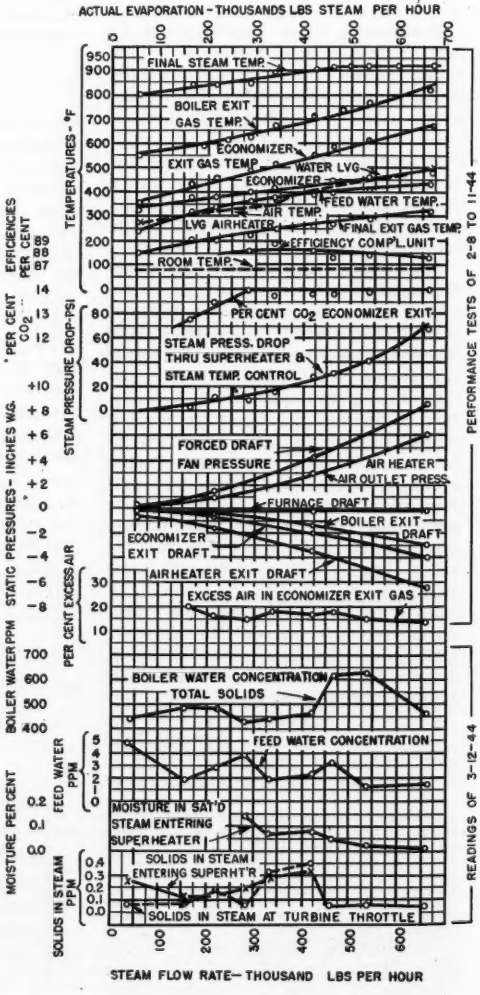
ACTUAL EVAPORATION - THOUSANDS LBS STEAM PER HOUR
FINAL STEAM TEMP.
BOILER EXIT GAS TEMP.
ECONOMIZER EXIT GAS TEMP.
WATER LVG. ECONOMIZER
FEED WATER TEMP.
AIR TEMP. LVG AIRHEATER
FINAL EXIT GAS TEMP.
EFFICIENCY COMP'L UNIT
ROOM TEMP.
PER CENT CO_2 ECONOMIZER EXIT
STEAM PRESS. DROP THRU SUPERHEATER & STEAM TEMP. CONTROL
FORCED DRAFT FAN PRESSURE
AIR HEATER AIR OUTLET PRESS.
FURNACE DRAFT
BOILER EXIT DRAFT
ECONOMIZER EXIT DRAFT
AIRHEATER EXIT DRAFT
EXCESS AIR IN ECONOMIZER EXIT GAS
BOILER WATER CONCENTRATION TOTAL SOLIDS
FEED WATER CONCENTRATION
MOISTURE IN SAT'D STEAM ENTERING SUPERHEATER
SOLIDS IN STEAM ENTERING SUPERHT'R
SOLIDS IN STEAM AT TURBINE THROTTLE
TEMPERATURES - °F
EFFICIENCES PER CENT
PER CENT CO_2
STEAM PRESSURE DROP-PSI
STATIC PRESSURES - INCHES W.G.
PER CENT EXCESS AIR
BOILER WATER PPM
FEED WATER PPM
MOISTURE PER CENT
SOLIDS IN STEAM PPM
STEAM FLOW RATE - THOUSAND LBS PER HOUR
PERFORMANCE TESTS OF 2-8 TO 11-44
READINGS OF 3-12-44

Fig. 5. Results of performance tests conducted by Department of Water and Power, Feb. 8, 9, 10, 11, 1944, and March 12, 1944. Operating pressure 1035 psi gage

Table showing overall efficiencies of steam generating unit and overall plant efficiencies, Harbor Steam Plant, Unit No. 1

Test No.	Load at Generator Terminals, Kw	Load Net Station Output, Kw	Lbs. Feed Water to Boiler per Hr	Lbs. Feed Water to Blr/Kwh at Generator Terminals	Fuel Oil Consumed Lbs/Hr	Btu per Lb Fuel Oil at Burners	Overall Thermal Efficiencies of Steam Generating Unit—Per Cent		Btu per Kwh	
							Predicted	Actual	At Generator Terminals	Net Station Output
1	4,813	3,568	63,808	13.25	4,473	18,338	84.5	84.0	17,043	22,989
2	18,999	17,610	169,575	8.92	12,359	18,332	86.7	87.0	11,926	12,866
3	24,825	23,338	221,632	8.92	15,484	18,333	87.3	87.8	11,435	12,163
4	33,062	31,400	289,890	8.80	19,411	18,305	87.3	88.0	10,747	11,316
5	39,796	37,661	344,570	8.68	23,013	18,306	87.2	88.4	10,586	11,186
6	50,203	47,889	427,633	8.68	28,677	18,305	86.8	88.4	10,457	10,962
7	54,198	51,755	465,469	8.60	31,163	18,325	86.7	88.2	10,536	11,034
8	62,846	60,230	541,108	8.62	35,954	18,324	86.3	87.8	10,484	10,939
9	74,637	71,596	658,921	8.70	43,310	18,353	85.7	87.4	10,650	11,102

and evaporators and the automatic control.

The standard instrument charts recording a 24-hr operating period with one revolution were of course not suitable for a comprehensive picture of the various data desired. The chart rotation of the instruments was therefore speeded up to a ratio of 60 to 1, so that a 24-min operating period was recorded during one complete revolution of the charts.

The data obtained during the test on October 12, 1944, as shown in Fig. 4, are representative of the boiler performance under the various quick load pick-up tests conducted. A comparison of this chart with the theoretical values of Fig. 3 indicates some similarity, but an exact duplication of the theoretical curves of quick pick-up is, of course, not possible and was not intended. Calculations showed 79 sec time required after the first impulse to establish normal operating conditions but 12 min were allowed during the tests.

The sharp rise in steam temperature prevented full use of maximum fuel burning capacity of 60,000 lb oil per hr. Even with the burning rate of 51,000 lb per hr, the steam temperature reached a peak of 975 F. It must be realized that the normal fuel consumption for 600,000 lb steam is only 42,000 lb. The difference, 9,000 lb per hr, was used to restore heat in the boiler water.

The steam output rate was up to approximately 650,000 lb per hr from the standby load of approximately 70,000 lb per hr within 5 sec, then settled back to 600,000 lb after 4 min. A momentary rise in water level of 9 in. was recorded. The feedwater regulator action was somewhat quicker than expected or desired. Large quantities of fresh water were fed to the drum at the instance of "swell." This resulted in higher than expected water level rise.

The boiler drum pressure drop was substantially less than expected, while the superheater steam outlet pressure dropped within 10 sec from an initial 1040 psig to approximately 800 psig. The steam temperature drop was less than expected, falling only to 810 F. The theoretical calculations predicted 560 F.

The oil burning rate reached a high of 51,000 lb. per hr approximately 2 min after the initial load pick-up. The high oil burning rate resulted in a temporary steam temperature peak of 975 F., although the steam temperature at the turbine throttle did not exceed 960 F. Heat pick-up by pipe lines and valves between boiler and turbine helped to keep the steam temperature at the turbine throttle within tolerable limits. In spite of the tremendous load surge, steam purity did not materially suffer. The highest entrainment recorded was below 0.5 ppm, while boiler water concentration was approximately 500 ppm.

The successful conclusion of these tests proved that the boiler unit is ready to take on the emergency load whenever required. Quick load pick-up tests are scheduled for regular intervals during the normal operation of the plant to detect possible faults in the system and to keep the operating personnel acquainted with the unusual performance conditions.

Normal Boiler Performance

The chart, Fig. 5, illustrates the result of normal boiler performance. Curves were plotted and are a composite of operating data recorded during official boiler tests of Feb. 8-11, 1944, and March 12, 1944. The results of the steam quality tests are interesting when compared with the steam quality results obtained during the quick load pick-up tests, Fig. 4. Sudden load variations appear to have little effect on solids entrainment in steam delivered to the superheater. Boiler water samples taken simultaneously from drums and water wall headers showed complete uniformity of concentration. This was interpreted to indicate good circulation in the evaporating system.

Efficient boiler performance not only from the standpoint of overall thermal boiler efficiency, but also from that of power consumption for fans, feed pumps and fuel preparation, is the first requirement for high station efficiency. Table shows the results of station efficiency test runs for nine load points. A heat input of approximately 11,000 Btu per kw-hr of net station output proves that the Harbor Steam Plant is one of the country's most efficient power generating stations.

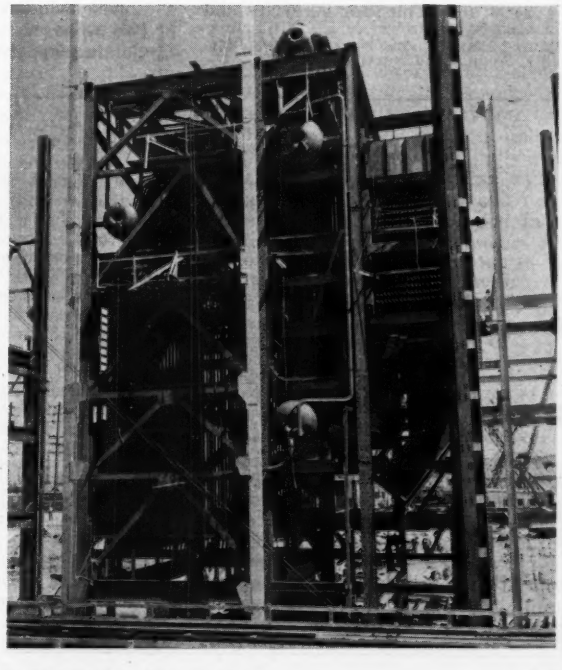

Fig. 6. Construction view of boiler unit. Heavy structural steel framing required by design for seismic shock

A New Armature Winding Diagram

PART V

BY WILLIAM T. TAYLOR

WINDING DIAGRAMS given in previous articles[1] reveal that the magnetic fields of multi-pole-pair windings take the form of full or partly full semi-circles (full for 4-poles), whereas the winding diagrams given herein reveal that the magnetic fields of one pole-pair or "unit" winding takes the form of a true polar curve.

The construction of this armature winding diagram is based on the fact that if two or more intermediate or phase coils lie in the same electrically identical positions in the magnetic field they and their vectors will coincide, the same phase-belt positions will recur under every pole for a full-pitch winding and the magnetic flux will divide into as many pole zones or magnetic circuits as there are poles in the winding. The amount of magnetic flux will of course depend upon the number of turns of wire in the coils themselves, the coil-throw and the current carried. This diagram shows that when the coil-sides span a full pole pitch the magnetic field strength and area are at their maximum.

The speed of the rotating field depends on the design of the machine and the desired or existing frequency. For no load conditions the synchronous speed in rpm of a "unit" machine is f (2 x 60) ÷ p = f (2 x 60 ÷ 2) = f60. Thus, for 60 cycles and 2-poles the synchronous speed is 60 x 60 = 3600 rpm; for 4-pole it is 3600 ÷ 2 = 1800 rmp; and for 8-poles it is 3400 ÷ 4 = 900 rpm.

The polar diagram (Fig. 1) and the straight-line diagram (Fig. 1a) reveal a 2-pole 3-phase 6-slot & coil full-pitch lap-winding layout. We see that this "unit" phase-winding has identical mechanical and electrical angular degree values and that *the phase groups repeat themselves in each magnetic pole.* Both diagrams visualize such information as the coil-pitch positions and angles, the the phase-belt boundary positions and angles, the phase-coil connection positions and angles, the phase-belt sequence, the phase-lead sequence, the equi-potential position and angles, the electrically identical positions and angles, and the magnetic-pole boundary positions and angles. Figs. 1 and 1a therefore reveal the coil, phase, pole and phase-lead (line and neutral) relations. They also reveal the correct coil-side *star* or the *delta* 3-phase connection positions, angles and relations.

We are able to see why one of the three phase-windings (say phase B Fig. 1) must be reversed in order to secure the necessary 120° angular phase displacement of the three phases.

Examination of Fig. 1 shows that a 6-phase winding is the equivalent of two 3-phase windings at 180°, i.e., by joining opposite phases such as coil sides 1 and 4 of phase A, 5 and 2 of phase B, 3 and 6 of phase C, we get a symmetrical 3-phase winding with the same number of circuits as the 6-phase winding from which the 3-phase winding is derived. This diagram shows that it is possible to obtain two circuits per phase from a 2-pole machine, and get half the number of phases from the same winding by reversing and process such as connecting opposite phases in series.

This form of winding diagram shows why mechanical rotation of a machine is reversed when two of the three phase-leads are reversed. Changing two of the phase leads changes the direction of current supplied and this causes a reversal in the mechanical direction of the rotor of an induction motor. And it shows why adjacent coils of a pole-phase group cannot be connected in parallel and why coil sides in the same electrically identical positions can be connected in parallel-visualizing at a glance all their positions and angles.

Figures 1 and 1a reveal that each phase winding has 2-slots and coils; that the angle between any two slots is 60°, or 180° ÷ (S ÷ p) = 180° ÷ (6 ÷ 2) = 180° ÷ 3 = 60°; that the number of slots and coils per pole per phase is 1, or, S ÷ p = 6 ÷ 3 x 2 = 6÷ 6 = 1; that the slot spacings per magnetic pole is 3, or S ÷ p = 6 ÷ 2 = 3; that with full-pitch coils the pole-zone-boundary angles are 180°,

[1]Power Plant Engineering of April, June, July, August and November of 1943.

A little over two years ago we presented the first of a series of articles dealing with a new type of armature winding diagram developed by the author, William T. Taylor. This diagram shows at a glance all the information that an engineer or operator needs to know about an armature winding.

The principles underlying the construction of this diagram were explained in the first article which appeared in the April 1943 issue. In the succeeding three articles Mr. Taylor covered the application of the diagram to various types of armature windings.

Now, Mr. Taylor presents a final article, one which is of special importance because it refers to the fundamental dynamo-electric machine, that is, the "unit" or 2-pole machine, the machine that discloses the most fundamental information because of the same mechanical and electrical degree relations. It may also be called the basic armature winding because it inherently visualizes the **real** star and delta phase-lead electrical positions as well as the true phase-neutral-lead positions and their electrical angular degree relations. Furthermore, it illustrates the correct vector angles and polarity of all the phase-leads from which the so-called "star" representation is derived.

On first thought it may seem that the 2-pole machine has limited use, but such is not the case. It is universally used for direct-connected steam turbines, diesel engine sets, frequency changers, motor-generators and a large percentage of small horsepower capacity induction motors. It is the simplest winding to understand and is the type most used for teaching purposes. In the case of the lap winding we have maximum simplicity because the phase-group connections are identical per pole pair, hence a 2-pole layout may be used to represent any number of pole pairs. Indeed there is no need to go beyond one pole pair for the purpose of illustrating or explaining the coil, phase group, phase winding, and system connections.

In the July 1944 issue of Electrical Engineering (Pages 254-263) Prof Robin Beach, describes a method based on the cross field theory for 2 and 4 poles. Differing from other writers, he locates the active field around the periphery where the slots and coils are Mr. Taylor's method, presented here, enlarges upon this same area in order to visualize the coil positions and their connections, the groups, the phases and the magnetic pole zones, and finally their correct angular degree relations.

This 2-pole winding diagram solves at a glance one of the most difficult winding problems, namely, what are the correct delta or star connection positions?

Actually, the diagram should be called an Armature Winding Diagram and Armature Winding Educator

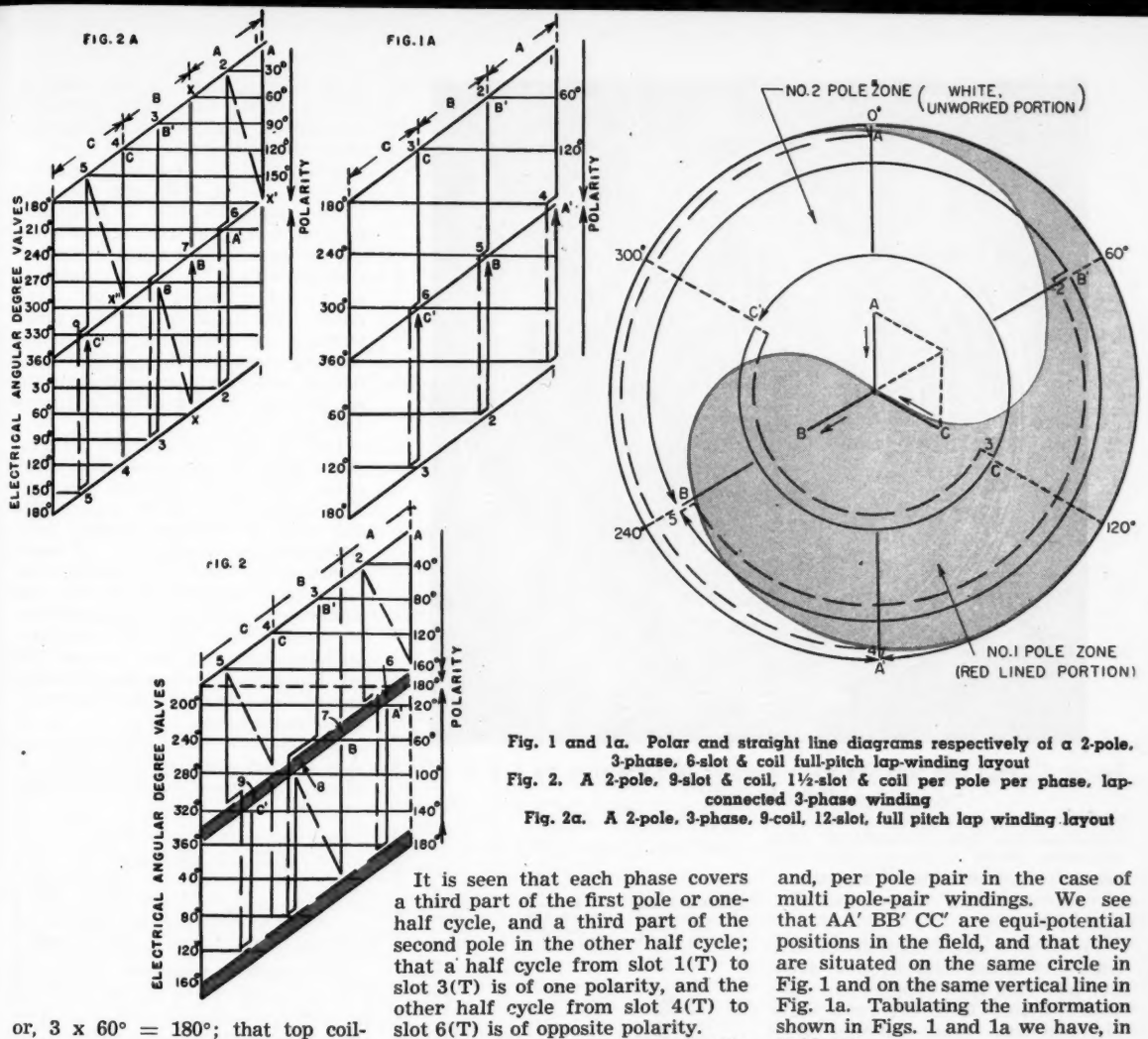

Fig. 1 and 1a. Polar and straight line diagrams respectively of a 2-pole, 3-phase, 6-slot & coil full-pitch lap-winding layout

Fig. 2. A 2-pole, 9-slot & coil, 1½-slot & coil per pole per phase, lap-connected 3-phase winding

Fig. 2a. A 2-pole, 3-phase, 9-coil, 12-slot, full pitch lap winding layout

or, 3 x 60° = 180°; that top coil-sides under the first pole are in slot 1(0°), slot 2(60°), slot 3(120°), and, top coil-sides under the second pole are in slot 4(180°), slot 5 (240°), and slot 6(300°). Figure 1 in particular reveals clearly a 2-layer winding with top (upper end) and bottom (lower end) full-pitch coil-sides distributed as in Table I.

It is seen that each phase covers a third part of the first pole or one-half cycle, and a third part of the second pole in the other half cycle; that a half cycle from slot 1(T) to slot 3(T) is of one polarity, and the other half cycle from slot 4(T) to slot 6(T) is of opposite polarity.

We see that each phase covers 120° divided into two halves, one part covering 60° of one pole in one direction, and the other half 60° of the other pole in the opposite direction, i.e., in the direction of arrow-heads in all cases. Each pole-phase group is connected in single series with the next pole-phase group per magnetic pole, and, per pole pair in the case of multi pole-pair windings. We see that AA′ BB′ CC′ are equi-potential positions in the field, and that they are situated on the same circle in Fig. 1 and on the same vertical line in Fig. 1a. Tabulating the information shown in Figs. 1 and 1a we have, in Table II.

Obviously the most logical step for pole-phase sequence is A B C, shown clockwise in Fig. 1 commencing at slot 1(0°). The resulting phase-*lead* sequence is A C B for clockwise direction and A B C for counter-clockwise direction of movement. As markings of this kind may get lost or be changed they are less important than knowing and actually seeing the real electrical angular degree values and their positions and relations, visualized in Figs. 1 and 1a.

The fully developed winding extracted from Figs. 1 and/or 1a is tabulated in Table III.

For a 3-phase star-connected winding phase-leads A′B′C′ would be joined together.

As six free ends come out of a 3-phase winding the question may arise as to how the six ends are connected to make a correct delta or star winding; in fact, if there is no terminal-board and no markings on the six phase-leads this is the question that would arise. Figs. 1 and 1a show that this form of diagram is inherently adaptable to the solution of this not uncommon problem; that it to say

(a)..For a *star* connection, first trace the phase-leads back to their

TABLE I

slot 1(T) phase A in the same potential position and angle as slot 4(B) phase A
slot 2(T) phase B in the same potential position and angle as slot 5(B) phase B
slot 3(T) phase C in the same potential position and angle as slot 6(B) phase C
slot 4(T) phase A in the same potential position and angle as slot 1(B) phase A
slot 5(T) phase B in the same potential position and angle as slot 2(B) phase B
slot 6(T) phase C in the same potential position and angle as slot 3(B) phase C
slot 1(T) phase A in the same potential position and angle as slot 4(B) phase A

TABLE II

Slot No.	Slot Angle	Phase	Pole No.	Connection Angle	Pole-phase Grouping	Phase and Lead	Coil Polarity
1	0°	A	1	0°	1	A (line)	positive
2	60°	B	1	60°	1	B′ (neutral)	positive
3	120°	C	1	120°	1	C (line)	positive
4	180°	A	2	0°	1	A′ (neutral)	negative
5	240°	B	2	60°	1	B (line)	negative
6	300°	C	2	120°	1	C′ (neutral)	negative
1	360°	A	1	180°	1	A (line)	positive

TABLE III

	T	B	B	T	
Phase A	1(0°)	4(180°)	1(0°)	4(180°)	A′ (neutral lead)
Phase B	5(240°)	2(60°)	5(240°)	2(60°)	B′ (neutral lead)
Phase C	3(120°)	6(300°)	3(120°)	6(300°)	C′ (neutral lead)

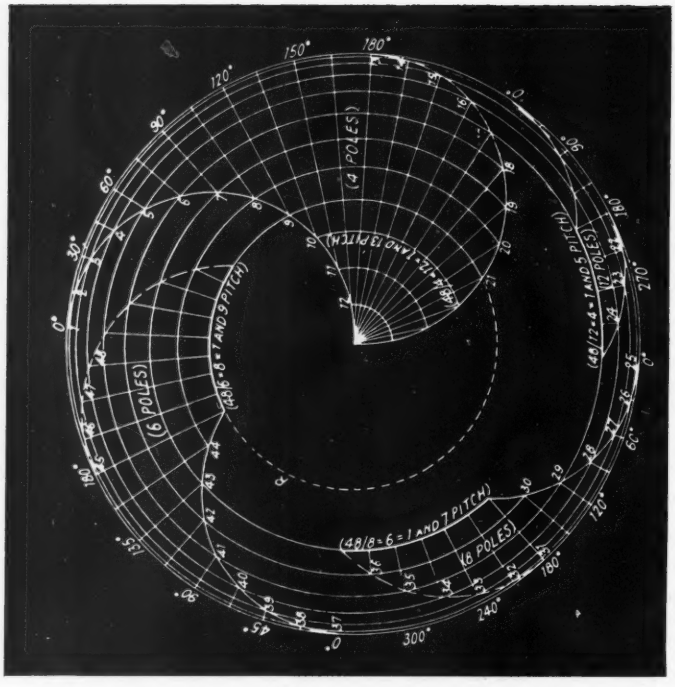

Fig. 3. A 48-slot core with one whole magnetic field drawn in for 4, 6, 8, and 12 poles, respectively

slot positions then connect any two *alternate* phase leads to form the neutral; thus, starting with phase A, join together B′A′C′—check with Fig. 1 and Fig. 4.

(b)..For a *delta* connection, first trace the phase-leads back to their slot positions then connect any two *adjacent* phase leads to form a phase line-terminal; thus, starting with phase lead A, join together AB′ for phase A terminal, CA′ for phase C terminal and BC′ for phase B terminal—check with Fig. 1 and Fig. 4.

For a lap winding the phase-lead positions ordinarily occur in the first and last magnetic poles, and the phase-coil positions remain unchanged no matter how many slots and coils there are per pole and phase. For a 2-pole 3-phase 2-layer lap winding the slot phase-coil numbers change in accordance with 1 + g; thus, for 3-slots and coils per pole per phase (See Table IV) the grouping is 1, 1 +3 = 4; 4 + 3 = 7, 7 + 3 = 10, 10 + 3 = 13 and 13 + 3 = 16. Phase-lead slot numbers for different pole-phase groupings are shown in Table IV.

A simple way to draw these *straight-line* diagrams is to first make a vertical line of evenly spaced dots to represent the slot positions, then make a horizontal line of evenly spaced dots to represent the phase-pitch positions which equal the number of slots per pole per phase. Draw the two outer vertical lines then the oblique pole-zone-boundary lines 180° for full pitch conditions). Now draw horizontal slot-lines between the two outstide vertical lines also the phase-pitch vertical lines so that they intersect the slot lines at the pole-zone boundaries. Thus we get a basic or skeleton winding diagram.

When a whole, or integer, number of slots and/or coils per pole and phase cannot be used, it is usually possible to obtain a balanced winding—so far as phase voltage are concerned—with a fractional number of slots and/or coils per pole and phase. But in order that the phase voltages be balanced, each phase winding must contain an equal number of active coils even though the number vary with the different poles (see Fig. 2).

Due to the fact that an integral slot full-pitch phase-winding comprises a complete or whole magnetic field and area it can be regarded as the basic or skeleton layout. In a fractional slot winding the slot angle positions are such as to change the coil, phase and pole pitch, also *the phase groups repeat themselves in every pole pair* (not in every pole such as occurs in the integral slot winding), and the resulting winding is both fractional slot and fractional pitch (see Fig. 2).

Figure 2 shows a 2-pole 9-slot and coil 1½-slot and coil per pole per phase, lap-connected 3-phase wind-

TABLE IV

Distribution Factor (k)	Coil grouping per hole per phase (g)	Total number slots and coils (S)	Phase and neutral leads					
			(A)	(B′)	(C)	(A′)	(B)	(C′)
			Angular displacement of phase leads					
			0°	60°	120°	180°	240°	300°
			Phase lead slot numbers					
1.000	1	6	1	2	3	4	5	6
0.966	2	12	1	3	5	7	9	11
0.960	3†	18	1	4	7	10	13	16
0.958	4	24	1	5	9	13	17	21

TABLE V

Slot No.	Angle of Slot	Phase	Pole No.	Connection angle	Pole-phase grouping	Phase and lead	Coil polarity	Coil-side phase overl ap
1	0°	A	1	0°	2	A (line)	positive	
2	40°	A	1	40°		A	positive	2(T) - 5(B)
3	80°	B	1	80°	1	B′ (neutral)	positive	
4	120°	C	1	120°		C (line)	positive	
5	160°	C	1	160°	2	C	positive	5(T) - 8(B)
6	200°	A	2	20°	1	A′ (neutral)	negative	
7	240°	B	2	60°		B (line)	negative	
8	280°	B	2	100°	2	B	negative	8(T) - 2(B)
9	320°	C	2	140°	1	C′ (neutral)	negative	
1	360°	A	1	180°		A (line)	positive	

TABLE VI

	(T)	(B)	(T)	(B)	(B)	(T)	
Phase A	1(0°)	5(160°)	2(40°)	6(200°)	1(0°)	6(200°)	A′
Phase B	7(240°)	2(40°)	8(280°)	3(80°)	7(240°)	3(80°)	B′
Phase C	4(120°)	8(280°)	5(160°)	9(320°)	4(120°)	9(320°)	C′

TABLE VII

Slot No.	Slot Angle	Slot Phase	Coil Angle	Coil Phase	Coil Grouping	Pole No.	Coils per pole	Phase and lead
1	0°	A	0°	A	2	1	1	A (line)
2	30°	A	30°	A		1	1	
3	60°	B	.....	.....		1	.....	
4	90°	B	90°	B	1	1	1	B′ (neutral)
5	120°	C	120°	C	2	1	1	C (line)
6	150°	C	150°	C		1	1	
7	180°	A	.....	.....		2	.....	
8	210°	A	210°	A	1	2	1	A′ (neutral)
9	240°	B	240°	B	2	2	1	B (line)
10	270°	B	270°	B		2	1	
11	300°	C	.....	.....		2	.....	
12	330°	C	330°	C	1	2	1	C′ (neutral)
11	360°	A	360°	A		1	1	A (line)

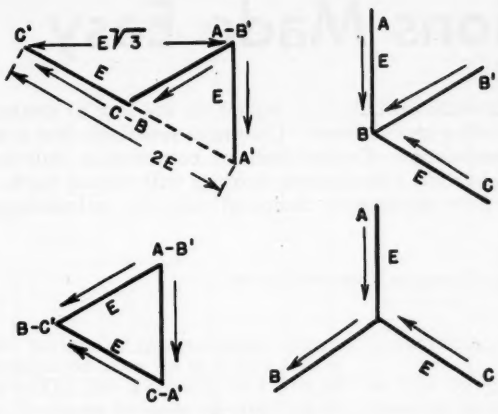

Fig. 4.

ing. This layout reveals that each phase has 3-slots and coils; 5-slots and coils in the 1st. pole and 4-slots and coils in the 2nd. pole; the angle between any two adjacent slots of 40°, or, $180° \div (S \div p) = 180° (9 \div 2) = 180° \div 4\frac{1}{2} = 40°$; the number of slots and coils per pole and phase is $1\frac{1}{2}$, or, $S \div \phi p = 9 \div 3 \times 2 = 9 \div 6 = 1\frac{1}{2}$; the number of slot spacings per magnetic pole is $4\frac{1}{2}$, or $9 \div 1\frac{1}{2} = 4\frac{1}{2}$, but the only practical pole-zone boundary angles are 160° for short pitch or 200° for long pitch, hence the winding is fractional slot ($1\frac{1}{2}$) and fractional pitch (see Fig. 2 for short pitch of 160°). It is seen that slots 1(0°) to 5(160°) lie under the 1st. magnetic pole while slots 6(200°) to 9(320°) lie under the 2nd. magnetic pole, and it is evident that the winding creeps in the magnetic field, i.e., the phase-pitch of slot 6 in phase A lies between slots 1 and 2, and the phase-boundary position of slot 7 lies between slot 2 in phase A zone and slot 3 inside phase B zone. Angles for the vectors of phase A are 0°, 40° and 200° — 180° = 20°, or three vectors 20° apart; angles for the vectors of phase B are 240° — 180° = 60°, 280° — 180° = 100° and 80°, or three vectors 20° apart; and angles for the vectors of phase C are 120°, 160° and 320° — 180° = 140°, or three vectors 20° apart. The general layout of Fig. 2 visualizes all the data tabulated in Table V

The fully developed winding table, extracted from Fig. 2, is shown as Table VI.

Figure 2a reveals a 2-pole 3-phase 9-coil 12-slot full-pitch lap winding layolt. Like Fig. 2 it is an unequally grouped coil winding with $1\frac{1}{2}$ coils per pole per phase, except that this winding is integral slot with full pitch coils whereas Fig. 2 winding is fractional slot and fractional pitch. Figure 2a visualizes all the information—shown in Table VII

The fully developed winding table, extracted from Fig. 2a, is shown as Table VIII .

Of all the armature winding diagrams so far produced, this *straight-line* diagram is the simplest, most easily made, visuaizes the maximum amount of information, and is an inherent winding-connection checker.

Figure 3 reveals a 48-slot core with one whole magnetic field drawn in for 4, 6, 8 and 12 poles, respectively. It shows that the pole-zone bouncurves differ from the 2-pole diagram. By doubling the pole arc it is seen that the number of poles are halved, i.e., by changing from 8 to 4 poles (see Fig. 3) the pole arc becomes $12 \div 6 = 20$, thus we have doubled the arc-gap section per pole, the number of slots, and the total slot cross section per pole. The required radial depth of iron behind the slots is also doubled; i.e., assuming a 4-pole to be $4 \div 4 = 1.0$, then the radial depth of iron for a change to 6-poles is $6 \div 4 = .666$; that for 8-poles is $8 \div 4 = 50$; and for 12-poles it is $12 \div 4 = .383$. The common design is a fixed contour and area of iron also a fixed radial length of air-gap due to the fact that economy demands as wide a use of available laminations as possible.

Questions

(1)..Knowing that a phase winding (phase B) is reversed in order to develop a 3-phase winding such as Fig. 1, which consists of 6 coils each, 60 electrical and 60 mechanical degrees apart, lay out the phase sequence and the phase-lead sequence—using Figs. 1 and 1a.

Ans. The sequence of pole-phase groups is shown in Table IX.

(2)..Whate visual means are there for proving the directions of currents in (a).. a *delta* connected winding; (b)..In a *star* connected winding?

Ans. (a)..Figure 1a shows that the direction of current in phase A-lead is from A to A' and the direction of current in phase B is from B' to B, therefore the directions of the two currents in phase A lead are away from A and from B' (opposed); the direction of current in phase C is from C to C' and the direction of current in phase A is from A to A' as previously stated, therefore the directions of the two currents in phase-lead C are away from C and away from A (not opposed); the direction of current in phase B is, as previously stated, from B' to B and the direction of current in phase C is from C to C', therefore the directions of the two currents in phase-lead B are towards B from C' and towards B from B' (not opposed). See Fig. 4.

(b)..The directions of currents (direction of arrow heads) are A to A' for phase A, B' to B for phase B, and C to C' for phase C. *Note:* Phase B is opposed to phases A and C in both cases.

(3)..The six outgoing stator leads of a 2-pole 3-phase *delta*-connected induction motor has accidentally been pulled apart from the machine terminal-board and none of the phase leads can be identified. What should be done to make a correct *delta* connection?

Ans. First trace three of the six leads back to their slot positions then: (a)..Assume any one position to be 0° and, for greatest simplicity, assume here that the other two positions are 120° and 240°, then the delta connection is 0°–60° for phase A, 120°–180° for phase C, and 240°–300° for phase B, i. e., the phase-lead sequence is A-B'-C-A'-B-C', and adjacent leads per

(Continued on page 124)

TABLE VIII

	(T)	(B)	(T)	(B)	(B)	(T)	
Phase A	1(0°)	x'	2(30°)	6(210°)	2(30°)	6(210°)	A'
Phase B	7(240°)	x	8(270°)	3(90°)	8(270°)	3(90°)	B'
Phase C	4(120°)	x"	5(150°)	9(330°)	5(150°)	9(330°)	C'

TABLE IX

Pole No.	1	1	1	2	2	2
Phase belt	0°-60°	60°-120°	120°-180°	180°-240°	240°-300°	300°-360°
Phase	A	B	C	A	B	C
Belt No.	1	2	3	4	5	6

And the phase-lead sequence is

Pole No.	1	2	1	2	1	2
Angle	0°-60°	240°-300°	120°-180°	180°-240°	60°-120°	300°-360°
Polarity	plus	minus	plus	minus	plus	minus
Belt No.	1	5	3	4	2	6
Slot-star angle	0°-60°	60°-120°	120°-180°	0°- 60°	60°-120°	120°-180°

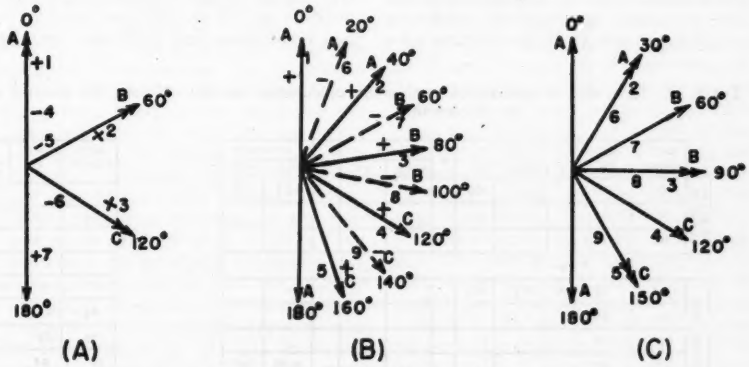

Fig. 5.

Combustion Calculations Made Easy

Theoretical combustion calculations based on the law of conservation of matter—The mol defined—Chemical reactions that take place during combustion—Explanation of combustion calculation tables—Combustion calculations dealing with actual fuels—Orsat analysis gives necessary chemical data for calculations

By **E. N. KEMLER** *Professor of Mechanical Engineering, Purdue University, Lafayette, Indiana*

SIMPLE as the making of calculations involved in combustion problems is in principle, in practice it becomes involved. The principle used in the making of combustion calculations is "The Law of Conservation of Matter" which will be discussed later. In actual combustion problems, where the chemical composition of the fuel and the products of combustion are known, the solution of problems can be obtained by application of this principle alone. In theoretical combustion problems, chemical equations must be written or the final products of combustion must be known. The following discussion points out how combustion calculations can be made using only the law of conservation of matter and the simple relation for making volume-weight conversions—

Weight of substance equals mols of substance times molecular weight.

The fundamental principle involved in the making of volume-weight conversions is Avagadro's law. This law states that "All gases at a given temperature and pressure have the same number of molecules in the same volume." Since the weight of a molecule is proportional to its molecular weight, the weight of the equal volumes of gases will be proportional to their molecular weights. For convenience it is desirable to select as a measure for gases a quantity called the "mol." The mol is defined as the quantity of a gas equal in weight to the molecular weight of the gas.

A mol of any gas at any given pressure and temperature will then occupy the same volume as a mol of any other gas. A mol as defined is, at any given pressure and temperature conditions, a volume measure. At standard atmospheric conditions of 14.7 psi and 70 F the volume of a mol of any gas will be approximately 358 cu ft.

The first part of this article will be concerned only with theoretical combustion problems. The reason for considering theoretical combustion first is that it is simpler, and second that problems often arise where the theoretical amount of air required for combustion may be desired. The discussion to follow in the latter part of the article will show how the results of actual combustion analysis can be used to find the per cent of excess air.

Law of Conservation

The law of conservation of matter as it applies to the combustion problem can be interpreted to state that the weights of fuel plus the weight of air supplied must equal the weight of products of combustion. The products of combustion may include ash as well as stack gases. Since chemical elements cannot be changed in form, the law of conservation of matter also says that the amount of any chemical element in the fuel plus the amount of that element in the air supplied must equal the amount of that element in the products. Since only oxygen and nitrogen are introduced in the air it means that the carbon in the fuel must equal the carbon in the products, etc. The oxygen to be supplied by the air must by the same reasoning be the difference of that in the products of combustion and that supplied in the fuel.

Theoretical combustion calculations generally mean those calculations to determine the amount of oxygen or air which will just be sufficient to combine with the fuel and have no free oxygen in the products. The composition of air is 20.9 per cent oxygen by volume and 23.15 per cent by weight. Another way of stating this is that 4.32 lb of air must be supplied to give 1 lb of oxygen and 4.78 cu ft of air must be supplied to give 1 cu ft of oxygen. Therefore 3.32 lb of nitrogen are associated with each pound of oxygen in the air and 3.78 cu ft of nitrogen with each cubic foot of oxygen in the air.

Chemical Reactions and Calculations

The most common chemical compounds and elements which are encountered in combustion calculations are C, H_2, CO, CH_4, S, C_2H_6. While the chemical reactions which occur are not used in the calculations, a knowledge of the products that result are necessary. For complete combustion the following reactions result.

$C + O_2 = CO_2$

$CO + \frac{1}{2}\ O_2 = CO_2$

$H_2 + \frac{1}{2}\ O_2 = H_2O$

$CH_4 + 2\ O_2 = CO_2 + 2\ H_2O$

$C_2H_6 + 3\frac{1}{2}\ O_2 = 2C\ O_2 + 3H_2O$

$S + O_2 = SO_2$

It will be noticed that wherever carbon and hydrogen are present, the final results with complete combustion are CO_2 and H_2O.

With this background we can now proceed with the calculations. In these calculations it is convenient to have a score card on which we can keep track of all of the chemical elements involved, since the law of conservation of matter says that they cannot be created or destroyed and further that the total of any one element in the fuel plus the amount of that element in the air must equal the amount of it in the products, or

Fuel + Air = Products.

Table IA shows such a score card. All of the calculations and all of the thinking on a combustion calculation can be included in this table. The following discussion gives a detailed

Table IA. First step in theoretical combustion calculation for 100 lb of carbon

	SUB-STANCE	MOL. WT.	FUEL %	FUEL MOLS	FUEL WT.	+	AIR MOLS	AIR WT.	=	PRODUCTS MOLS	PRODUCTS WTS.
CHEMICAL ELEMENT	C	12		8.33	100					8.33	100
	O_2	32									
	N_2	28									
TOTAL											
ACTUAL SUB.	C	12	100	8.33	100					0	
	O_2	32								0	
	N_2	28									
	CO_2	44								8.33	367

Table IB. Second step in theoretical combustion calculation for 100 lb of carbon

SUB-STANCE	MOL WT.	FUEL %	FUEL MOLS	FUEL WT.	+	AIR MOLS	AIR WT.	=	PRODUCTS MOLS	PRODUCTS WT.
C	12		8.33	100					8.33	100
O_2	32					8.33	267		8.33	267
N_2	28					31.5	886		31.5	886
				100 +			1153 =			1253
C	12	100	8.33	100					0	
O_2	32					8.33	267		0	
N_2	28					31.5	886		31.5	886
CO	44								8.33	367
				100 +		1153	=			1253

Table III. Complete calculation for a gaseous fuel.

	SUB-STANCE	MOL. WT.	FUEL %	FUEL MOLS	FUEL WT.	+	AIR MOLS	AIR WT.	=	PRODUCTS MOLS	PRODUCTS WTS
CHEMICAL ELEMENTS	C	12		100	1200			0		100	1200
	H_2	2		200	400			0		200	400
	O_2	32					200	6400		200	6400
	N_2	28					756	21,170		756	21,170
	TOTAL				1600	+		27,570	=		29,170
ACTUAL SUBSTANCE	CH_4	16	100	100	1600						
	O_2	32					200	6400			
	N_2	28					756	21,170		756	21,170
	CO_2	44								100	4400
	H_2O	18								200	3600
	TOTAL				1600	+		27,570	=		29,170

Table IV. Composition of a specific gaseous fuel

Fuel Composition by Volume

CO	26.8%
CH_4	1.6%
H_2	5.2%
CO_2	8.2%
O_2	0.2%
N_2	58 %

Composition of Dry Products of Combustion

CO_2	19.4%
O_2	2.5%
N_2	78.1%

explanation of the why and wherefore of each calculation in the various stages. As the basis for calculations, it is convenient to take 100 lb of fuel if the analysis is given as per cent by weight and 100 mols of fuel if the analysis is per cent by volume.

Table IA shows the general form of the table together with the first step in a theoretical combustion calculation for 100 lb of carbon. The upper part of the table is a score card and contains information on the chemical elements involved. It can also be used to check the other calculations. The lower part of the table contains information on the actual chemical substances involved. The method can best be explained by following through a detailed analysis. The basis for calculation in this example is 100 lb of carbon, since the fuel is 100 per cent carbon by weight.

The first step is to determine the mols of carbon present. (This assumes C as a gas for purposes of calculation only.) The mol of carbon will be the weight of carbon divided by molecular weight. In the score card at the top is listed 8.33 mols and 100 lb of carbon. Since no carbon is present in the air there must then be 8.33 mols of carbon in the products of combustion. From the above chemical formulas it can be seen that the carbon will combine with oxygen to form CO_2.

Since this is theoretical combustion all the carbon is assumed to combine with oxygen and no free oxygen will be left over. Hence under actual substances the amount of C will be O and the amount of O_2 will be O. Since every molecule of CO_2 contains a molecule of C, every mol of C will result in one mol of CO_2 hence the mols of CO_2 will be the same as the mols of carbon or 8.33. The weight of CO_2 will equal the mols of CO_2 x molecular wt = 8.33 x 44 = 367 lb.

The second part of the calculation is shown in Table IB. The only place oxygen occurs in the products is in the CO_2. Since one mol of CO_2 requires one mol of O_2, the number of mols of O_2 required will be 8.33. The wt of O_2 will be 8.33 x 267. Since there was no oxygen in the fuel this amount of oxygen must have been supplied in the air. Since each mol of oxygen is accompanied by 3.78 mols of nitrogen, the mols of nitrogen will be 8.33 x 3.78. The weight of nitrogen can be found by multiplying the mols of nitrogen by its molecular weight. The weight of nitrogen can also be found by multiplying the weight of oxygen by 3.32. The detailed calculations under air do not have to be made since the weight of air per pound of oxygen is 4.32 and the weight of air would be 4.32 x 267 = 1153. This type of table gives all the information that might be desired. It will be noted that the weight of chemical elements plus weight of air equals weight of products. The same also holds true for actual substances. The table then gives an easy check on the results. This table shows that 11.53 lb of air are required for combustion of 1 pound of carbon.

Table II lists in tabular form the complete calculations for a gaseous fuel. In this case 100 mols of fuel have been taken as the basis for the calculation. The steps are the same as before. (1) Divide the fuel into chemical elements and list in the upper part of the table. (2) Since none of the chemical elements in the fuel appear in the air they must all be present in the products. (3) Since carbon appears only in CO_2 the mols of CO_2 must be equal to the mols of C. Likewise since hydrogen appears only in H_2O, the mols of H_2O must be equal to the mols of H_2. (4) The mols of O_2 combined with the fuel can be found to be 200 since each mol of CO_2 has 1 mol of O_2 (making total of 100 for CO_2) and each mol of H_2O has ½ mol of O_2 (making total of 100 for H_2O). (5) Since all the O_2 is supplied in the air the weight of air will be equal to 4.32 x 6400 = 27,570 or can be found as shown in table and as outlined in previous example.

Table III. Calculation of theoretical air required for combustion of a coal

SUBSTANCE	MOLECULAR WEIGHT	FUEL % WT.	FUEL MOLS	FUEL WT.	AIR MOLS	AIR WT.	PRODUCTS OF COMB. DRY %	PRODUCTS OF COMB. MOLS	PRODUCTS OF COMB. WT.
C	12		5.47	65.6				5.47	65.6
H_2	2		2.94	5.88				2.94	5.88
O_2	32		.58	18.55	6.41	204		6.99	223
N_2	28		.03	0.70					
S	32		.05	1.60				.05	1.60
					881				
C	12	65.6	5.47	65.6					
H_2	2	5.88	2.94	5.88					
O_2	32	18.55	0.58	18.55				0	0
N_2	28	0.70	.03	0.70					
S	32	1.60	.05	1.60					
ASH		7.75		7.75					7.75
CO	28								
CO_2	44							5.47	241
H_2O	18							2.94	52.9
SO_2	64							.05	3.2
		100							

Table III lists the detailed calculations necessary for the calculation of the thearetical air necessary for a coal. It will be noted that when the chemical analysis is given in terms of the chemical elements themselves that the upper part of the table for the fuel and air is identical and need not be repeated. The method to be followed is identical with the previous example. The carbon, hydrogen and sulfur are followed across. The ash will be present in both fuel and products. The CO_2 will be determined by the mols of C, the H_2O by the mols of H_2 and the mols of SO_2 by the mols of S. The mols of oxygen will be the mols of O_2 in CO_2 (5.47) plus mols of O_2 in H_2O (½ x 2.94 = 1.47) plus mols of O_2 in SO_2 (0.05). The mols of O_2 to be supplied by the air will be the mols of O_2 in the products less that in the fuel = 6.99 — 0.58 = 6.41. The pounds of air supplied can be determined as shown or will be 204 x 4.32 = 881. The pounds of air theoretically required per pound of fuel will be 881 ÷ 100 = 8.81.

Actual Combustion Calculations

Actual combustion calculations differ from theoretical calculations only in that the chemical composition of the products must be determined by analysis of a sample of the products. The analysis is usually made by means of an orsat apparatus which gives the percentage by volume of the dry products which include CO_2, O_2, N_2 and CO. The data shown in Table IV lists the per cent by volume for a gaseous fuel. The table also lists the orsat analysis of the dry products. In addition to these dry products there will be some water vapor (H_2O) present. As in the previous examples the complete analysis can be made by inserting the values in a table. Table V shows a complete calculation of an actual combustion prob-

Table V. Complete calculation of an actual gas combustion problem

SUB-STANCE	MOL WT	FUEL			+	AIR		=	PRODUCTS OF COMB		
		%	MOLS	WT		MOLS	WT		ORSAT %	MOLS	WT
C	12		36.6	439						36.6	439
H_2	2		8.4	17						8.4	17
O_2	32		21.8	698		23.75	760			45.55	1457
N_2	28		58	1624		89.58	2508			147.58	41.32
TOTAL				2780	+		3268	=			6045
CO	28	26.8	26.8	750							
CH_4	16	1.6	1.6	26							
H_2	2	5.2	5.2	10							
CO_2	44	8.2	8.2	361					19.4	36.6	1610
H_2O	18									8.4	151
O_2	32	.2	.2	6		23.75	760		2.5	4.75	152
N_2	28	58.	58.	1624		89.58	2508		78.1	147.58	4132
TOTAL		100	100	2777	+	113.33	3268	=		197.33	6045

Table VII. Complete combustion calculation for a coal fuel based on 100 mols of dry products

SUBSTANCE	MOLECULAR WEIGHT	FUEL			AIR		PRODUCTS OF COMB.		
		% / WT.	MOLS	WT	MOLS	WT	ORSAT % PER VOL	MOLS	WT.
C	12		14.40	173				14.40	173
H_2	2		6.3	12.6				6.3	12.6
O_2	32		.5	15.9	21.66	693		22.16	709
N_2	28		.09	2.5	79.91	2265		81.10	2268
S	32		.04	2.7				.04	2.7
C	12	76.78	14.40	173					
S	32	1.18	.08	2.7					
H_2	2	5.60	6.3	12.7					
O_2	32	7.02	.50	15.9	21.66	693	4.50	4.50	145
N_2	28	1.11	.09	2.5	79.91	2265	81.10	81.10	2268
ASH		8.31		18.8					18.8
CO	28						0.10	0.10	3
CO_2	44						14.30	14.30	630
H_2O	18							6.3	114
SO_2	64							.08	5

Table VI. Composition of a specific coal fuel

Composition of Coal by Weight

C	76.78%
S	1.18%
H_2	5.60%
O_2	7.02%
N_2	1.11%
Ash	8.31%

Composition of Dry Products

CO	0.10%
CO_2	14.30%
O_2	4. 5%
N_2	81. 1%

lem. As indicated previously the table does not always have to be completed. Where such calculations are frequently made, a mimeographed form can be used to eliminate the routine work of inserting chemical compounds, elements, the molecular weight and headings.

The calculation given in Table V is carried out on the basis of 100 mols of fuel since the analysis is given as per cent by volume. The chemical elements in the fuel are found as before. The carbon is made up of that in the CO (26.8 mols) plus that in the CH_4 (1.6 mols) plus that in the CO_2 (8.2 mols) making a total of 36.6 mols. The hydrogen is that in the CH_4 (2 x 1.6 mols) plus the free hydrogen (5.2 mols) giving 8.4 mols total. The mols of O_2 will be that in the CO (26.8 x ½ = 13.4 mols) plus that in the H_2O (½ x 5.2 = 2.6) plus the free O_2 (0.2 mols) making a total of 21.8 mols. The nitrogen is 58 mols. The mols of carbon and hydrogen in the products must be the same as in the fuel since none has been added. The carbon all goes to CO_2 making 36.6 mols of CO_2. Since the hydrogen all goes to H_2O there will be 8.4 mols of H_2O.

In an actual combustion problem where two independent analyses are given it is necessary to tie the two together in some manner. The carbon usually forms the basis for such tie in. In this example we know that for 100 mols of fuel there will be 36.6 mols of CO_2 if all the carbon is to be accounted for. Since the orsat analysis shows 19.4 per cent CO_2 we can now interpret the product analysis in terms of the other quantities. The 19.4 per cent of CO_2 must equal 36.6 mols. 1 per cent = (36.6 ÷ 19.4) mols. The mols of any other gas can then be found directly by multiplying the per cent orsat by (36.6 ÷ 19.4). The total oxygen in the products will be that in the CO_2 (36.8 mols) plus that in the H_2O (½ x 8.4 = 4.2 mols) plus the free oxygen (4.75 mols) giving a total of 45.55. The O_2 added brought in by the air was that in the products less that in the fuel or 45.55 — 21.8 = 23.75 mols. The weight of air supplied can be found as shown or will be 23.75 x 32 x 4.32 = 3268. The per cent excess air will be the ratio of the extra O_2 divided by the theoretical air which will be

$$\text{Excess air} = \frac{4.75}{23.75 - 4.75} = \frac{4.75}{19}$$

$$= 25 \text{ per cent}$$

$$\text{Pounds of air per pound of fuel} = \frac{3268}{2777} = 1.18$$

The equivalent molecular weight of the products of combustion = 6045 ÷ 197.33 = 30.6. The equivalent gas constant, R, of the mixture will be 1545 ÷ 30.6 = 50.5.

Table VI lists a coal composition and the corresponding analysis of dry products. Table VII gives the complete combustion calculation for this condition. In a case such as this the calculation can be made on the basis of 100 lb of fuel if desired. However, the basis used in Table VII is 100 mols of dry products. The reason for this being that when this basis is used

(Continued on page 124)

Table VIII. Complete combustion calculation for a coal fuel based on 100 lb of fuel

SUBSTANCE	MOLECULAR WEIGHT	FUEL			AIR		PRODUCTS OF COMB.		
		% / WT.	MOLS	WT.	MOLS.	WT.	ORSAT %	MOLS.	WT.
C	12		6.56	78.78				6.56	78.78
H_2	2		2.80	5.60				2.80	5.60
O_2	32		0.22	7.02	9.81	315		10.03	322
N_2	28		0.04	1.11	36.86	1029		36.9	1030
S	32		0.04	1.18				.04	1.18
C	12	78.78	6.56	78.78					
H_2	2	5.60	2.80	5.60					
O_2	32	7.02	0.22	7.02			4.50	2.05	65.6
N_2	28	1.11	.04	1.11			81.10	36.9	1034
S	32	1.18	.04	1.18					
ASH		8.31		8.31					8.31
CO	28						0.10	0.045	1.26
CO_2	44						14.30	6.518	287
H_2O	18							2.80	33.0
SO_2	64							0.04	2.56
				100					

The PRACTICAL ENGINEER and ELECTRICIAN

ANDREW W. KRAMER, EDITOR

☆

Lou Newman's Turbine Articles Save the Day

A prominent electric utility company engineer in commenting on the material in recent issues of Power Plant Engineering, tells us how one of Lou Newman's articles on Extraction Turbines helped him to hold some of the company's business which they were in danger of losing.

"The Sales Department," he related, "came to me with a call for help several weeks ago when one of the big downtown office buildings which we serve were considering the installation of an extraction steam turbine which, of course, would have resulted in cutting out our service for steam and electricity. According to their figures the proposition looked very favorable. Using the method described in one of Mr. Newman's articles for figuring the expected performance of extraction turbines, I was able to uncover an error in our customer's calculations and, as a result, the sales department was able to convince them that the proposed move was not to their advantage. I think we will hold their business."

☆

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Soldering, Brazing and Low Temperature Welding

By RENE D. WASSERMAN
Eutectic Welding Alloys Company

AT THE PRESENT TIME there are available three processes for joining metals. Two of these, soldering and brazing, have been in existence for many years, centuries in fact, but the third, Low Temperature Welding, is only a few years old. In this discussion we will consider the first two rather briefly and then proceed to a more detailed consideration of "Low Temperature" Welding.

Available in every hardware store or "Five and Ten Cent Store" are the soft solders. These are the alloys applied below 750 F which simply adhere to the surface of the parent metal. They must be used on ferrous and non-ferrous metals.

Soft solders are predominantly combinations of lead and tin in varying proportions, although for certain applications small additions of anti-

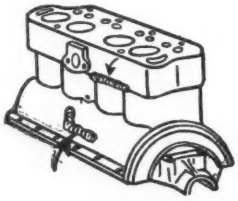


Fig. 1. Cracked motorblock salvaged with Low Temperature Welding (EutecRod 15)

mony, cadmium or silver may be added to obtain particular properties.

When preparing to solder, the parts to be joined must be thoroughly cleaned and degreased and then fluxed. The fluxes for soft solders are of two general types. There are mild fluxes, such as rosin and stearine, which are applied before heating to prevent the formation of oxide on the base metals. Then there are scavenger fluxes, such as zinc chloride, zinc ammonium chloride, and orthophosphoric acid, which will actually clean oxidized or tarnished metal surfaces. These fluxes, however, should be completely removed from the work after soldering as they are quite corrosive, and may damage the finished assembly.

The heat for soft soldering may be applied by a soldering "iron," which is actually copper, by dipping the parts to be joined in molten solder, or by sweating, which is usually accomplished by means of a blow torch, acetylene and air torch, or oxy-acetylene torch.

Soft solders are always used for sealing lap joints which are generally not intended to develop particularly great strength.

What Is Brazing?

Now, brazing has been defined as the joining without fusion, of various metals in similar or dissimilar combinations by means of a non-ferrous alloy filler material. In other words, "Brazing" is similar to soft soldering, except that the temperature range for brazing starts at approximately 1200 F and goes up to approximately 2000 F. The bonding action of a brazed joint is again essentially a sweating operation in which the molten brazing alloy flows between lapped or butted surfaces which have been heated slightly above the melting point of the brazing alloy. When brazing, almost all joints are lap joints, as the brazing alloys are not designed to have much strength in themselves. In fact, the clearances between the parts must be held within fairly narrow limits, if the maximum strength of the joint is to be obtanied. It has been shown that the maximum strength of brazed joints is generally obtained with a clearance of approximately 0.0015 in. with the strength rapidly falling off to a fraction of this maximum value when the clearance exceeds 0.020 in.

Preparations for brazing are quite similar to those for soldering, in that the parts must be cleaned and degreased, then fluxed and assembled. The temperature at which brazing is done is so high that the use of "irons" to apply heat is no longer practical, so the heat is generally applied by some type of torch, in an oven or by high frequency induction units.

There are in general two types of brazing. The most commonly used is the high melting brass type brazing alloys and the second type is the low melting silver solders or silver brazing alloys. The brass type alloys have melting points between 1600 to 1800 F and are generally made of copper and zinc. Another type of brazing which requires still higher temperatures is copper brazing which is done in controlled atmosphere furnaces.

"Bronze-Welding" is a variation of the use of brazing alloys in bevelled butt joints or as the filler materials for fillet welds. The strength of such joints is determined by the bond of the brazing alloy to the base metal and the strength of the brazing alloy itself.

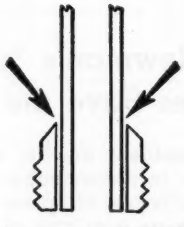


Fig. 2. Brass nipple Low Temperature welded to tubing (EutecRod 1800)

Silver soldering is performed very similarly to brazing with brass alloys except that the temperatures required are generally lower, ranging from 1200 to 1600 F. In general, silver solders are alloys composed of various proportions of silver, copper and zinc. They are applied as described before and will generally develop the strength of the base metals being joined, if the proper clearances and amount of over-lap are used. Silver solder should not be used for square butted joints.

"Low Temperature" Welding—A New Process

I feel particularly qualified to speak on this new process as I spent the last twelve years on the research work which resulted in its discovery. I introduced "Low Temperature"

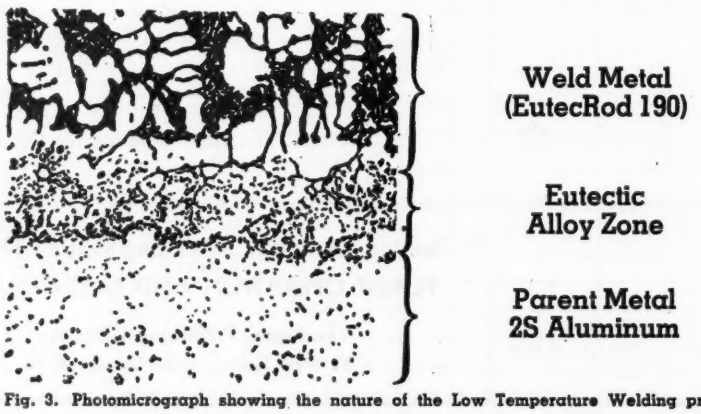


Fig. 3. Photomicrograph showing the nature of the Low Temperature Welding process

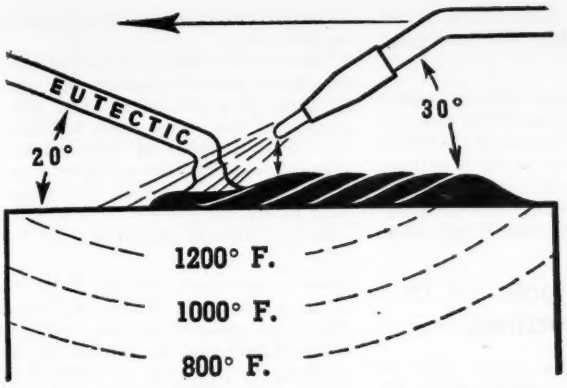


Fig. 4 (Above). Illustrating the principle of applying Eutectic Alloys at low temperatures

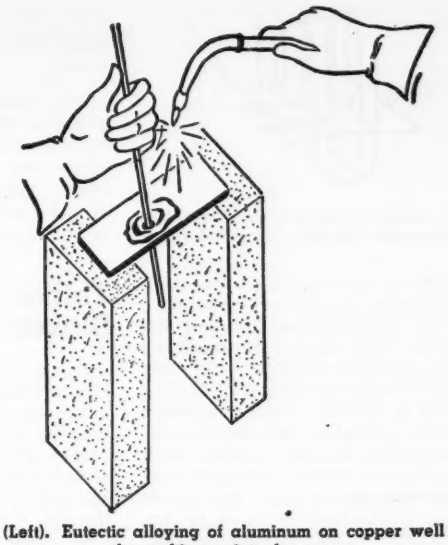


Fig 5 (Left). Eutectic alloying of aluminum on copper well below the melting point of copper

welding to the American industrial market just before Pearl Harbor. "Low Temperature" welding intentionally makes full use of the phenomenon of surface-alloying which in the past had been practically ignored. That is, for "Low Temperature" Welding, alloys have been developed for each application on all commonly used metals.

Studies were made to determine the affinity of various metals for each other. Then filler rods were created, which, besides containing components of the metal or alloy they were designed to weld, contained those metals which had a particularly strong affinity for the metals in the parts being joined. In short, a eutectic alloy film is formed on the surface of the base metal where the welded metal is applied (U. S. Patent Pending). This means that a bond between the weld metal and the base-metal can be obtained without melting the base metal. In many cases the base metal may be 400 to 1000 F below its melting point.

This new type of welding rod can be classified in two groups—one: the thin flowing group which first flows through capillary action and then alloys itself with the surface of the parent metal. This type is used mostly for joining sheet, tubings and shapes. The second group is the bead forming type which is applied similarly to fusion welding and is used generally for welding of castings, metals of poor conductivity and for parts which cannot be heated broadly.

The first type is used for butt and lap joints without a chamfer. A tensile strength as high as 140,000 to 160,000 psi can be obtained with a clearance of 0.002 in. It is important to remember, however, that with a larger clearance of 0.030 in. the tensile strength is still as high as 80,000 to 90,000 psi. The bead forming type gives very satisfactory tensile strength values on steel as high as 75,000 psi in a 90 deg "V".

"Low Temperature" Welding is generally done with the oxy-acetylene flame. The thin flowing type, which has a lower melting point, can be applied with gas flames, in furnaces or with induction heating. The bead forming type and in general the "Low Temperature" alloys melting above 1200 F can all be applied with atomic hydrogen or with carbon arc, which would be advantageous when the heated area must be reduced to a minimum. There are eight types available for metallic arc applications for felding cast iron, malleable, alloy steel, bronze, copper, aluminum and hard overlays.

The technique is quite similar to brazing. The parts must be cleaned, coated with flux, and then heated. The alloy is applied without fusion of the parent metal. But here the similarity ends. The temperatures are averagely lower than those of brazing and the affinity of the alloys for the parent metal is greater, resulting in a joint that is metallurgically a real weld.

What has happened is that a liquid alloy has formed itself on the parent metal at a temperature pre-indicated by the melting of the flux, especially designed for each welding rod. This surface alloy is the eutectic alloy of those metals present at the point of union with the parent metal. The flux has acted very much in the manner of a catalyst, reducing surface tension, preventing oxidation, and aiding in alloying.

As you know, eutectic is a metallurgical term which refers to the lowest melting alloy of the series of alloys which may be made from any given group of metals. The "Low Temperature" welding rods are not all eutectic alloys, but the reaction occurring between the weld material and the base metal during the operation produces a eutectic alloy on the surface of the base metal. Because of this alloying effect this process is definitely "welding," although the alloys may be applied far below the fusion temperature of the base metals.

The Eutectic process is well illustrated by a simple experiment. A sheet of copper is coated with the appropriate flux for an aluminum "Low Temperature" welding rod. The copper plate is heated and when the melting flux indicates that the flow point of the rod is reached, the end of the rod is pushed straight down onto the copper plate. If the copper plate is held at this temperature for just a few seconds the aluminum alloy rod will make a sharp hole right through the copper. This hole is the result of the eutectic alloy of copper and aluminum being formed which has a melting point some 700 F below the melting point of copper. This alloy being completely molten at this temperature has allowed the aluminum rod to be passed through the copper at that point.

The advantages of "Low Temperature" welding are obvious. The lower temperatures applied to the parts being joined mean less distortion and in many cases practically no metallurgical change in the base metal and in the filler metal. Welding rods based on the theory of this process have been developed for practically every alloy, including cast iron, malleable iron, all types of steel, copper base metals, including aluminum bronzes, nickel alloys, aluminum alloys, magnesium, tungsten carbide and even zinc die castings. Not only are these rods adapted to joining these various metals, but for each group several different varieties have been created

Fig. 6. Tipping tools with Low Temperature Welding (EutecRod 16)

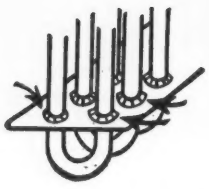


Fig. 7. Copper piping fabricated with Low Temperature Welding (EutecRod 18)

with various melting points thus making it possible to solve extraordinary problems. For instance, to repair delicate cast iron cases with cracks, an alloy is available that requires only 354-600 F where no danger of further cracking is present. Another example is in the joining of aluminum heat-treated parts. For this purpose there is an alloy which will join parts below drawing temperature. In the case of steel parts that have to be annealed after "Low Temperature" joining, there is a rod which bonds at 1300 F and remelts between 1700-1800 F which will stand annealing without damage to the joint.

Thus "Low Temperature" rods are available for joining, filling up missing metal or filleting. They can be used for overlaying — some special rods were developed especially for protection against frictional wear. These are available in two types— the non-ferrous, whose ferrous base gives a hardness up to 300 Brinell and which are applied between 1000 and 1200 F and the ferrous base type which is the hardest up to 620 Brinell and require local heat to approximately 1800 F.

The filler rods generally contain the same metal or metals as the base metals they are designed to weld.

It may be interesting at this point to mention some of the applications in various fields this new process has found. First—in the production joining of light and medium gage materials and dissimilar metals or gages. The main advantages are greater speed of application, less distortion and, because of the low temperatures metallurgical changes in the parent metal are often completely avoided. A further important advantage is the fact that the joints are extremely clean and require a minimum amount of finishing.

The second field is in salvaging defective castings and parts. The low temperatures used will prevent distortion even of completely machined parts. Further, an added advantage

Fig. 8. Broken arm welded with Low Temperature Welding (Eutecrod 210)

is that the joints cannot be detected, being color matched with the parent metal.

The third field is that of repair welding. Many of the filler rods being adaptable to numerous metals or alloys, the job can be done without exactly determining the composition of the part. Further, the temperatures being lower, pre-heating can be reduced—thus, it speeds and simplifies repair work.

An ever increasing number of manufacturers have recognized the value of these new procedures and processes and are using them alongside the older methods of oxy-acetylene and arc welding. There is no doubt that they have been of tremendous help in solving many war production and maintenance problems.

Things to Look for in Stoker Operation

SOME TIME ago a reader (EK) of POWER PLANT ENGINEERING asked for information on a very interesting subject, that of the smoking and discharge of gas from the hopper of one of two underfeed stokers. This smoke and gas, it was pointed out, came out through the top of the hopper and also at the joint between the hopper and the stoker mechanism. I have had it in mind to write to you in regard to some of the ailments likely to occur to stokers. There are many plants now using stokers which formerly burned oil and the engineers are likely to be baffled as to the reason for the troubles that might arise. I have had my share of the troubles, so can speak from experience. If what I learned can be of use to someone, then I will feel gratified and am glad to pass it on.

E. K. states that if they cut off the forced draft, it helps. Is the main damper a single or multibladed damper? I have had multibladed dampers come apart and only have one open and the other two closed. If E. K. has an induced draft fan, are the blades worn or clogged up with soot? I have found them both ways, causing a bottled up condition. Is the I. D. fan up to speed? If it is driven by a two speed motor it may be running on low speed all the time; if V-belt driven, the belts may be loose or slipping.

The fuel bed may be too low, coal too coarse, dirty fires, the wind box may be stuffed up. If the coal is too coarse, the degree of packing is at a minimum and offers practically no resistance to the flow of smoke and gases out through the hopper. Use a smaller size of coal. Dirty heating surfaces may cause trouble, smoke pipe or breeching may be filled with soot or fly ash.

The hopper may be empty or coal has arched across the bottom of the hopper. Another reason for smoke, especially with a heavy load, is an unduly heavy fuel bed and a fire having too many clinkers; this causes excessive resistance to the gases which normally come through the fuel bed with resultant smokeback. How long has it been since the wind box has been cleaned of siftings and dust? Is the coal wet and sticking in hoppers? The fuel bed may be too low, that is the coal may be burning too deep in the retort and the F. D. fan is open too much. There may be an excess of clinkers in the retort. A large clinker may be forming or has formed, hanging over the edge of the retort immediately about the front of the retort. It will direct the stream of air downward and aggravate the burning conditions deep into the retort.

I once had to blank off all the air ports at the front end tuyere blocks to stop this trouble. In large heating jobs, where in mild weather the coal will sometimes bank in the center of the retort and channel around the sides, the fuel bed will be low and on long stand-by periods almost burn out. When the stoker starts, the coal banking in the center shuts off the air from going through the fuel bed, and the only air that gets through is that which goes around the sides of the bank. This forces the smoke back through the hopper; this will happen whether the coal is a coking or free burning coal. I found the remedy is to take a bar and gently break the bank of coal in the center. This breaks up the cake bank or crust so as to admit air through the fuel bed. Those are a few of the difficulties that may be encountered. I have had experience with most of them.

Here are some more difficulties and some of the solutions for their correction in stoker firing.

Difficulty in Cleaning Fires.

1. Periods too long between cleaning
2. Insufficient grate area
3. Coal with extremely low ash fusion temperature
4. Lack of proper cleaning knowledge and tools

Excess Fuel Consumption.

1. Using coal too low in heat value
2. Lack of air in boiler room to supply air to F. D. fan
3. Excess air through the fuel bed due to leaks around the dead plater, etc.
4. Improper adjustment of forced draft air supply and stack draft
5. Dirty boiler flues and smoke passages
6. Accumulation of dirt and scale in boiler
7. Oil or grease in the boiler water
8. Fuel bed carried too thin
9. Improper fuel distribution

Failure to Carry Load.

1. Check all points listed under excess fuel consumption
2. Load may be greater than calculated
3. Stoker may be too small. Insufficient draft
4. Insufficient furnace height between dead plater top of furnace
5. Improper or careless operation

Burning of Dead Plates, Tuyeres and Dump Plates.

This has been the cause of my worst headaches. Some of the reasons are:

1. Fuel bed carried too thin
2. Blow holes through the fires, producing a destructive heat
3. No room or space left between plates or tuyeres for expansion
4. Improper distribution of fuel by the pusher blocks
5. Stoker not adjusted to maintain a constant even fuel bed

6. Stock not properly dampered—fire burns down into retort at night after banking
7. Insufficient ash left on dead plate after cleaning fires
8. High sulphur content in fuel
9. Improper dead plate arrangement—no cooling effect from forced air and wind box
10. Fire cleaned too frequently with low ash fuels
11. Insufficient draft causing a bottled up condition in the fire box
12. Fire not cleaned often enough when high ash coals

There are a lot more reasons I have found, but this will be a starter.

Frequent Shearing of Safety Keys or Pins.

1. Feed worm may be bent from forcing rods or other obstructions through the worm housing
2. Feed worm off at retort end.
3. Tramp iron, rocks, wood, shale, etc.
4. Coarse, hard coal, clinkers formed in retort from stoker being idle for long periods
5. Burning the fuel down into retort because coal feed rate too slow or shut off.

Leominster, Mass. George A. Aiken

Pilot Light

By Thomas Trail

IN A LARGE hotel a pair of pumps that pump water from the city mains to storage tanks on the 22nd floor of the building are installed. The pumps are controlled by an automatic switchboard that regulates their operation by means of float switches mounted on the tanks.

Since these pumps are unattended, any failure of electric power, as for instance the blowing of a line fuse, might go unnoticed until the tanks became empty. This would have very undesirable results, aside from the inconvenience of depriving the guest rooms of water supply, since the flushometer type toilets, of which there are hundreds in the building, are particularly affected by sediment stirred up in the piping when water again flows through.

To guard against such a current failure going unobserved, a pilot light has been installed in the office of the chief engineer. This light is of the same voltage as the pump power line and is connected directly across the line wires. The pilot light burns continuously and helps provide illumination in the office. Consequently, should the pump power supply fail the light would go out and the reduction of illumination in the office would be easily and quickly noticeable.

Recently this pilot light even provided an indication of motor trouble. The light flickered momentarily and it was discovered that the cause had been a flashover on one of the pump motors. This had evidently resulted in a brief reduction of line current, thus dimming the light for an instant.

Determining Overall Diameter of Galvanized Steel Strands

By F. C. DeWeese

MOST ENGINEERING handbooks which treat with wires and cables contain tables of the characteristics and loading of galvanized steel strands for the various strandings. Such tables, however, usually give the nominal diameter of the cable and the actual diameter of the individual wires, but do not generally give the actual overall diameter.

Since, due to war restrictions on other types of conductor materials, steel is being used to an increasing extent for overhead transmission line conductors, making it necessary to know the approximate overall diameter of the strands. The writer has developed the following equations which may be used for this purpose.

3 strands, $D = \sqrt{\text{cir mils}}\,(1.5486)$ mils (1)

7 strands, $D = \sqrt{\text{cir mils}}\,(1.2877)$ mils (2)

19 strands, $D = \sqrt{\text{cir mils}}\,(1.3175)$ mils (3)

For example, compute the overall diameter of 3/8 in., 3-strand cable

Diameter of each wire = 165 mils, from which $165^2 \times 3 = 81{,}765$ cir mils.

From (1)

$D = \sqrt{81{,}765 \times 1.5486} = 356$ mils = 0.356 in.

For 3/8 in., 7-strand, diameter of each wire = 120 mils.

From which $120^2 \times 7 = 100{,}800$ cir mils.

From (2) $D = \sqrt{100{,}800 \times 1.2877} = 360$ mils = 0.360 in.

When the overall diameter of any particular stranding is known, the constants in equations (1), (2) and (3), may be derived as follows. Take for example, No. 1, 3-strand copper, for which the overall diameter is given as 0.360 inch.

$\sqrt{\text{cir mils}}\,(C - 1/3N) = D$ (4)

The cross-sectional area of No. 1 copper = 83,690 cir mils

N = number of wires = 3. 1/3N = 1/9 = 0.1111

D = 0.360 in. = 360 mils diameter.

From (4), solving for the unknown "C"

$\sqrt{83{,}690}\,(C - 0.1111) = 360$

$83{,}690\,(C - 0.1111) = 360^2$

$83{,}690C - 2326 = 129{,}600$

$C = 131{,}926/83{,}690 = 1.5764$, from which $(C - 1/3N) = 1.5764 - 0.1111 = 1.5486$, as in (1).

In this manner short-cut methods may be developed for use, regardless of the stranding.

Since galvanized steel strands are made up of 3, 7, or 19 strands, equations (1), (2) and (3) cover the required range.

"I told them the chief engineer was in the next building, but they keep hanging around!"

What the Power Engineer Should Know About

THE SLIDE RULE

Part II.

By DENARD LEE GUSLER

IN THE ARTICLE in the May issue we discussed the use of the slide rule in performing simple operations such as multiplication, division and proportion. We will now consider some practical problems in which the operations of multiplication and division will be combined and it is here that we will really begin to appreciate the slide rule.

You are meandering through the power house and decide to check the switchboard to see if anything is wrong with the meters.

The following readings are obtained:

Kilowatts = 9600
Volts = 11,500
Amperes = 930
P. F. = 0.90

Outwardly this seems O.K. but let's check these readings against each other using the formula **Volts x amps x PF = Kw.**

11,500 x 930 x 0.90 = ?

Set the right index of C opposite 11,500 on D.

Move the hair line to 930 on C.

Move the left index of C under the hair line.

Shift the hair line to 0.90 on C.

Read the answer 962 under the hair line on D.

To locate the decimal

$1.1500 \times 10^4 \times 9.30 \times 10^2 \times 0.9 = 9.62 \times 10^6 = 9{,}620{,}000$ watts or 9620 kw which checks close enough with the kwhr meter reading.

Now bear this in mind. Once you have made a routine calculation of this type and located the decimal you will not have to use a pencil or scratch paper again. When you pass by the switchboard just haul out the old rule and make a check. No fuss, no bother. Perform a few similar operations and think it over.

In the course of further inspection you pause by your old, but still energetic pre-World War I engine. You run an indicator card to see what the ancient baby is doing.

Using the equally ancient formula $Hp = \frac{PLAN}{33{,}000}$, you obtain the figures

$$Hp = \frac{52 \times 4 \times 624 \times 240}{33{,}000} = ?$$

On the slide rule:

Set the hair line to 52 on D.

Move 33 on C under the hair line.

Move the hair line to 4 on C.

Move the right index of C under the hair line.

Move the hair line to 624 on C.

Move the left index of C under the hair line.

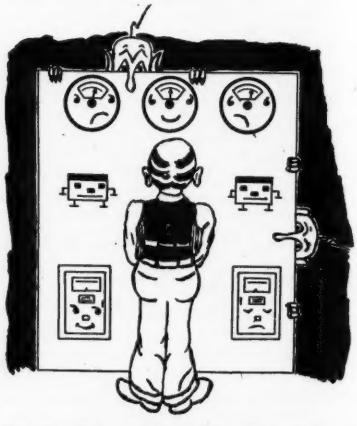
Move the hair line to 240 on C.

Read the answer under the hair line on D as 945.

To locate the decimal

$\frac{52}{33 \times 10^3} \times 4 \times 6.24 \times 2.4 \times 10^4 = 94.5 \times 10^1 = 945$ hp Ans.

Here again, once you have worked this problem, you will not have to worry about finding the decimal point in later problems of the same type. You can work such problems as rapidly as you can shift the scales on the rule; and that, brother, can be pretty fast *if you practise.*



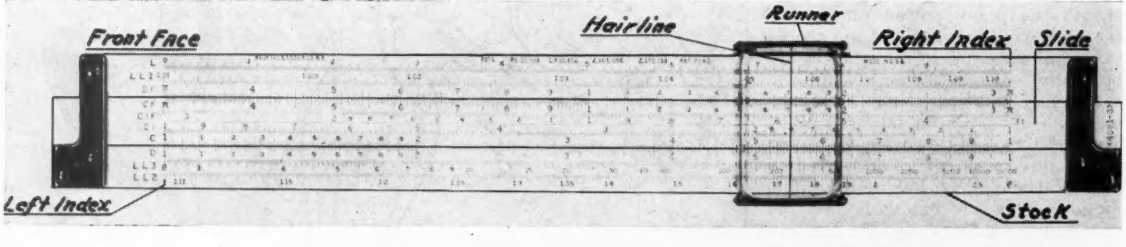
You decide to check the switchboard to see if maybe something is wrong

The important point is that any routine formula ordinarily encountered can be solved as indicated and these time savers will repeat themselves—often.

Square Root

All of us know it is quite a job to sit down and figure out the square root of a number. If it is not done often the process is easily forgotten. On the slide rule, however, you can square or obtain the square root of a number in one easy operation.

In Fig. 1b you will note that the A scale is divided into A left and A right. With the rule closed as shown, the following rule is applicable. To find the square root of a number between 1 and 10, set the hair line to the number on A scale left and read the an-



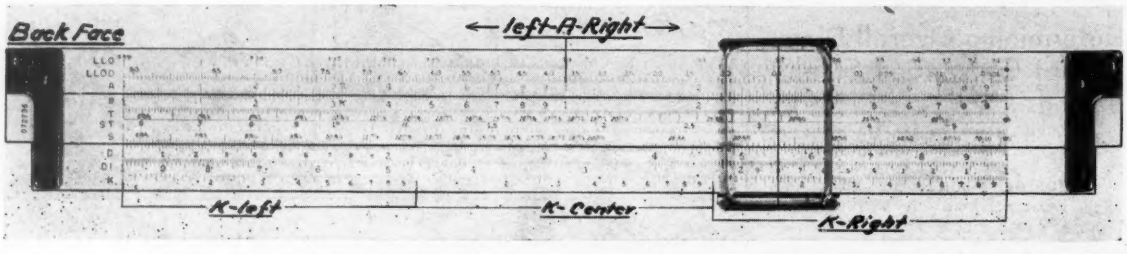


Fig. 1a (above) and Fig. 1b (below): Front and back respectively of a log log, duplex, decitrig slide rule

swer under the hair line on scale D. To find the square root of a number between 10 and 100 move the hair line to the number on scale A right and read the answer under the hair line on scale D.

The most difficult part, as usual, is the location of the decimal point. Here is a foolproof method.

Example: $\sqrt{27,400}$

Sectionalize these figures in the usual manner as 2'74'00.

Now write it as $2.74'00 \times 10^4$. Since this number is less than 10, move the hair line to 2.74 on A left. Under the hairline read the answer 1.655 on scale D. When using exponents and you want the square root you simply divide the exponent by 2. In this case 10 to the fourth power divided by 2 equals 10 to the second power or 10^2. Thus the final answer is $1.655 \times 10^2 = 165.5$. Ordinarily you would make these simple arithmetical calculations mentally.

Example : $\sqrt{274,000}$

Sectionalize as 27'40'00

Write as $\sqrt{27.4 \times 10^4}$

Move the hair line to 27.4 on A, right.

Read the answer under the hair line on D as 5.24

Final answer $5.24 \times 10^2 = 524$

Cube Root

It is just as easy to find the cube root of a number. Incidentally, do you remember how to find the exact cube root? No—well this will refresh your memory without any additional elaboration.

Example: Cube root of 11,390,625

			11,390,625 | 8
3×20^2	=	1,200	3,390
$3 \times (20 \times 2)$	=	120	
2^2	=	4	
		1,324	2,648
			742,625
3×220^2	=	145,200	
$3 \times (220 \times 5)$	=	3,300	
5^2	=	25	
		148,525	742,625

Somewhat exhausting, isn't it?

Again referring to Fig. 1b note that the K scale is divided into three sections. Namely: K left, K Center, and K right. To find the cube root of a number between 1 and 10 set the hair line to the number on K left. Read the answer on D scale under the hair line. For a number between 10 and 100 use K center and for a number between 100 and 1000 use K right.

Example: $\sqrt[3]{11,390,625}$

Write as: $\sqrt[3]{11.390'625 \times 10^6}$

Set hair line as nearly as possible to 11.39 on K center.

Under the hair line on D read the answer 2.25.

Since 10^6 must be divided by 3 we have 10^2.

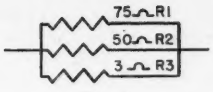


Fig. 2

Final answer $2.25 \times 10^2 = 225$.

Example 2: $\sqrt[3]{9,750}$

Write as $\sqrt[3]{9.750 \times 10^3}$

Set hair line to 9.75 on K left.

Under the hair line on D read 2.135.

Final answer $2.135 \times 10^1 = 21.35$.

This should give you the general idea. Study the problem carefully and practise on other examples. We have a lot more to cover and cannot spend anymore time on roots.

Logarithms

Do you know how to use logarithms? If not, you can skip this part but you should learn how to use logarithms because they are very useful and not at all difficult to understand. Almost any ordinary book on practical mathematics will tell you all you need to know about them.

If you do know how to use logarithms, you will appreciate the L scale because with it you can find the log of a number to the base 10 and you do not have the interpolate.

Example: Log 27

Characteristic is 1.

Set the hair line to 27 on D.

Under hair line on L read .431+

Thus log 27 = 1.431 accurate to three places.

Example 2: Log 532

Characteristic is 2.

Set the hair line to 532 on D.

225 ans.

Under the hair line on L read .726.

Thus log 532 = 2.726.

It is as simple as that and amazingly close to the log table values, considering the fact that we are relying on visual accuracy.

Reciprocal Scale

Comes now the CI scale which on the rule in Fig. 1 is a D scale printed backwards in red figures hence it must be read from right to left. Remember that the reciprocal of a number is nothing but 1 divided by that number.

Example: the reciprocal of 14 or $\frac{1}{14}$

Close the rule and set the hair line to 14 on C scale.

Under the hair line on CI read 714.

Mentally place the decimal and the answer is .0714.

Example 2: $\frac{1}{3}$

Set the hair line to 3 on C scale.

Under the hair line on CI read 333.

Final answer .333.

The advantages of this scale become apparent when we are confronted with unequal resistors in parallel such as shown in Fig. 2 or problems of a like nature.

Their combined resistance is found by the formula

$$Rt = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

$$\text{Thus } Rt = \frac{1}{\frac{1}{75} + \frac{1}{50} + \frac{1}{3}}$$

To 75 on C set hair line.

Under hair line on CI read .0133

To 50 on C set hair line.

Under hair line on CI read .02

To 3 on C set hair line.

Under hair line on CI read .3333

Total = .3666

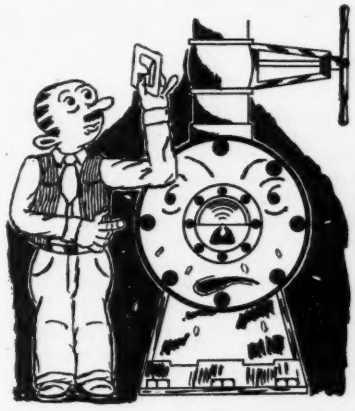
To .3666 on C set hair line.

Under hair line on CI read 2.73

Final answer 2.73 ohms.

Tangent and Sine Scales

We will now consider the T (tangent), ST (sine tangent) and S (sine) scales. These are trigonometrical scales that may be used in solving any problems involving angles. We



You take an indicator card to see what the ancient baby is doing

can use these scales to find the sine, tangent, cosine, and cotangent of any angle and without interpolating as is necessary when using the regular trigonometric tables.

Although it does not show in Fig. 1b the figures on the T and S scales reading from left to right are black. They are used for sines and tangents. The figures on the S and T scales reading from right to left are red. They are used for cosines and cotangents.

The ST scale is used for angles 5.74° and under. It will not be discussed in this article. To perform the following operations keep the rule closed.

Example 1: Find sin 76°

Set hair line to black 76 on S.

Under hair line on D read answer .97.

Example 2: Find sin 10°

Set hair line to black 10 on S.

Under hair line on D read answer .1736.

Example 3: Find cos 80°

Set hair line to red 80 on S.

Under hair line on D read answer .1736.

Example 4: Find cos 30°

Set hair line to red 30 on S.

Under hair line on D read answer .866.

The T scale only goes up to 45° so we will use two scales both the D and the CI. We know that the contangent is $\frac{1}{\tan}$ or the tangent is $\frac{1}{\text{cotan}}$. Now let's see how this works out.

Example 1: Find tan and cotan 40°

Set hair line to black 40 on T.

Under hair line on D read tan 40° = .839.

Turn the rule over and under the hair line on CI read cotan 40° = 1.19.

Example 2: Find tan and cotan 60°

This angle is larger than 45° so we will find the cotan first.

Set hair line to red 60 on T.

Under the hair line on D read cotan 60° = .577.

Turn the rule over and under the hair line on CI read tan 60° = 1.732.

So much for cut and dried procedure. Operations of the above nature should be practised with the aid of the "trig" tables until they are perfectly familiar.

Note: This is the second of several articles on the slide rule by the author. The first appeared in the May issue. A third article discussing other practical problems will appear in a subsequent issue.

Complete Directions
For Testing Boiler Water
and Operating Softener

By Urban C. Fleming, Jr.

Several months ago a reader[1] asked how much M-H alkalinity his boiler water should show. His raw feedwater which was treated by a cold process lime and soda softener had a hardness of 7 gr per gal and his boiler was a 500 hp, 4-drum bent-tube boiler. They were getting some carry-over but he suspected that this was because of the poor manual regulation of the water level.

Before going into this phase of boiler water conditioning this engineer should determine whether his lime-soda softener is being properly operated so that the correct amount of alkalinity can be maintained without the use of excessive blowdown. Through proper operation of the lime-soda softener it should be possible to reduce the hardness to such an extent that the effluent from the softener would have about 15-20 ppm of hardness expressed as $CaCO_3$. This water would then require internal conditioning with some kind of a sodium phosphate in order to insure against scale formation on the boiler tubes and drums.

Lime Soda Feed Controlled by Tests Need for Alkalinity

The amount of lime and soda ash to be fed to the softener may be controlled and maintained at the proper value by means of several simple tests, the procedures for which will be given later in this article. The tests which must be made on the effluent are 1, Phenolphthalein Alkalinity; 2, Methyl Orange Alkalinity; 3, Soap Hardness.

The following limits should then be maintained in the effluent from the lime-soda softener.

2 × Phenolphthalein alkalinity — Methyl orange alkalinity (or 2P—MO) should be between 0.5 and 1.0 cc of N/50 sulfuric acid. This corresponds to a hydroxide concentration of from 10 to 20 ppm expressed as $CaCO_3$. If the value 2P—MO exceeds 1 cc of acid (P = phenolphthalein alkalinity; MO = methyl orange alkalinity) the lime feed should be reduced and if 2P — MO is less than 0.5 cc of acid, the lime feed must be increased. By maintaining 2P — MO between 1 and 2 cc, the most favorable results are obtained.

The second formula that must be used in controlling the operation of the softener is the formula that indicates the excess soda ash in the effluent from the softener. This formula is 2 (MO — P) — H where H = Number of cubic centimeters of soap solution used in the hardness test. The value of 2 (MO — P) — H should be between 1.0 and 1.5 cc which corresponds to an excess of from 20 to 30 ppm of soda ash expressed as $CaCO_3$. These limits have been found to yield most favorable results in the operation of a lime-soda softener.

If the value of 2 (MO — P) — H exceeds 1.5 cc, the soda ash feed to the softener should be decreased and if the value of 2 (MO — P) — H is less than 1.0 cm the soda ash feed should be increased.

To illustrate the application of the above formulas let us take an analysis of an effluent from a lime-soda softener.

P reading = 2.5
MO reading = 3.0
H reading = 0.8

In this case 2P — MO = 5 — 3 = 2 cc, 2 (MO — P) — H = 2 (3 — 2) — 0.8 = 1.2 cc.

We find from the above information that the value for 2P — MO is 2 cc and, therefore, the lime feed to the softener must be decreased. However, since the value for 2 (MO — P) — H is 1.2 cc, it is within the established limits, and, therefore, the soda ash feed not be changed.

Once the proper conditions have been established in the effluent from the lime-soda softener it remains only to provide for proper conditioning of the boiler water itself. In order to insure against scale formation, some type of sodium phosphate must be fed to the boiler in order that the hardness in the entering feedwater is properly taken care of and removed as a sludge of calcium phosphate. To insure against scale formation on the interior of the boiler, a minimum of 30 to 40 ppm of PO_4 must be maintained in the boiler water. The Taylor phosphate comparator appears to be the most simple apparatus for carrying out the phosphate test.

Need for Alkalinity

In conjunction with the maintenance of this minimum phosphate concentration in the boiler water, it is necessary also to have a certain amount of alkalinity in the boiler water at all times to provide for the proper sludge formation and to insure removal of any magnesium hardness that may enter the boiler, as well as to provide against corrosion.

The most ideal test for alkalinity in boiler waters appears to be the test for hydrate or hydroxide alkalinity, the procedure for which is included in this paper. The proper limits for alkalinity in a boiler water are from 8 to 12 cc of N/50 sulfuric acid when the test is carried out according to the following procedure. This corresponds to a hydroxide alkalinity of from 160 to 240 ppm of hydroxide alkalinity expressed as $CaCO_3$. This would correspond roughly to a total alkalinity of about 500 ppm or 500/17.15 = 29.1 grains per gallon of total alkalinity expressed as $CaCO_3$.

Test Procedures

1. Phenolphthalein Alkalinity—A 50 50-cc sample of boiler or feedwater is measured by means of a graduated cylinder and poured into a clean casserole of 200 cc capacity. Five drops of phenolphthalein indicator are added and, if the water is alkaline in nature, the indicator will turn red. Then standard N/50 sulfuric acid is added from a burette until the point is reached where one drop of acid changes the color of the solution from red to colorless. The total number of cubic centimeters of acid required is then recorded. During the addition of the acid to the solution in the casserole, the sample of water should be stirred with a glass stirring rod. The number of cubic centimeters of N/50 sulfuric acid used represents the P reading and is substituted in the formulas 2P — MO and 2 (MO — P) — H.

2. Methyl Orange Alkalinity—A 50-cc sample of water to be tested is measured out in a graduated cylinder and poured into a clean 200-cc cas-

[1] See Question by E. O. D., page 110, Oct., 1944, issue.

serole. Five drops of methyl orange indicator are added to the water in the casserole and then N/50 sulfuric acid is added from a burette to the water in the casserole with stirring until the color of the solution changes with the addition of one or two drops of acid from yellow to light pink. This is the endpoint of titration. The number of cubic centimeters of acid required to cause this change in color represents the MO reading and the value for the number of cubic centimeters of N/50 sulfuric acid used may then be substituted in the formulas 2P — MO and 2 (MO — P) — H.

3. **Hardness Test**—A 50-cc sample of water to be tested is measured out in a 50-cc graduated cylinder and poured into a clean 8-oz glass-stoppered bottle. Soap solution (standard soap solution 1 cc = 1 milligram of $CaCO_3$) is added slowly to the water in the bottle. After the addition of the 10 or 12 drops of soap solution, the stopper is replaced in the bottle and the bottle is shaken. Sufficient soap solution has been added when a permanent lather is obtained on the sample. The permanent lather is one which will not break on the surface of the liquid in the bottle when the bottle is shaken and turned on its side and allowed to stand for five minutes.

As the endpoint of this titration is approached, the soap solution must be added only a few drops at a time and the bottle stoppered and shaken and a check should be made for a permanent lather after each addition of a few drops of soap solution.

Watch for False Indication in Making Test

There is a point in this titration which sometimes tends to mislead a person carrying out the test. After the addition of a certain amount of soap solution a lather develops which appears to be permanent. However, if a slight amount of soap solution is added to the solution at this point the lather is found to be not permanent. This is a "Ghost Point" and, to make certain that the final end-point has been reached, after a permanent lather is obtained, about 10 extra drops of soap solution should be added and the bottle shaken. If the lather remained permanent the original endpoint may be considered correct. If the lather does break in less than five minutes, continue to add soap solution until a permanent lather is obtained.

The number of cubic centimeters of soap solution required to produce a lather in a test of this type, where distilled water is used, represents the lather factor and must be subtracted from the number of cubic centimeters of soap solution used in the test on a water sample. This lather factor is generally about 0.3 cc.

Therefore, the value H which represents the number of cubic centimeters of soap solution required to combine with the hardness in any water sample is equal to the number of cubic centimeters of soap solution used in the test less the lather factor. The result is the value H.

The value of H in cubic centimeters may then be substituted in the formula 2 (MO —P) —H.

To obtain the value for the hardness of the water in parts per million, H is multiplied by 20.

4. **Hydroxide Alkalinity** — A 50-cc sample of boiler water is measured out in a graduated cylinder and added to a 200-cc casserole. Five cubic centimeters of barium chloride solution (10 per cent) are added to the water in the casserole and the water sample is stirred vigorously. Then five drops of phenolphthalein indicator are added to the water sample in the casserole and N/50 sulfuric acid is added from a burette to the sample in the casserole, with stirring until the addition of one or two drops causes the color of the solution in the casserole to change from red to colorless. This is the endpoint in the titration. The number of cubic centimeters of N/50 sulfuric acid required represents the hydroxide alkalinity reading. The number of cubic centimeters of N/50 sulfuric acid required in this test should be between 8 and 12 cc if the proper alkalinity is to be maintained in the boiler water. This corresponds to a hydroxide concentration of from 160 to 240 ppm of hydroxide expressed as $CaCO_3$. If the hydroxide alkalinity reading exceeds 12 cc, the amount of caustic soda or soda ash fed to the boiler water should be decreased or the blowdown should be increased. Likewise, if the hydroxide alkalinity reading is less than 8 cc, the amount of caustic soda or soda ash fed to the boiler should be increased.

These procedures are similar to those that may be obtained from any text on water analysis, i.e., the APHA Water Analysis Book, Solvay Bulletin No. 11 "Water Analysis" or the Betz Handbook on Water Analysis.

With the present trend toward higher pressures in steam generating equipment, most steam engineers are becoming aware of the need for close technical control of feedwater conditioning and it appears that, in the not too distant future, the majority of men in charge of steam generating equipment will find it necessary to adopt some type of chemical control of their boiler water conditions. Large, high pressure boilers must be kept on the line, continuously, over long periods of time without cleaning.

Our Diesel Crew

By Basil Miller

(Written Dec., 1941)

Now LISTEN Kramer, from me to you,
And I'll tell you about our Diesel crew.
We have right now, Oh let me see,
We should have four, got only three.
Now if you'll promise it's all in fun,
I'll begin this story with number one.

They hired this man from the vale of tears
Because his experience was eleven years.
His big cigars go PUFF, PUFF, PUFF,
He mopes around like in a huff.
He's short and squatty and his nose, it winds,
He talks with his hands, like monkey shines.
He reads farm papers, he should have a horse,
He always reverts to Fairbanks Morse.
I hope this story no man offends,
You know this man, it rhymes with Zens.

Now let's get down to number two,
And remember what I promised you.
You know the way they got those numbers,
Some men have "night-mares" in their slumbers.
A bright idea one night had he,
He said, "we'll call them one, two three."
The first one hired was number one,
Because a Fairbanks Morse he'd run.
The second one don't have such gall,
He's big and broad and rather tall.
He wasn't so good to "pull the reins,"
But what he had, was a lot of brains.
He knows his engines to a high degree,
And willing to help out number three.
So all in all he's the best of the crew,
But we never call him "number two."

Number three as the story goes,
Was a local man right on his toes.
He never claimed an engine he'd run,
He wasn't so lucky as number one.
Convinced the Council he'd be a good man,
And do his job as best he can.
He came on the job as green as grass,
But never tries the buck to pass.
He tries to learn and works like a horse,
The better he is without Fairbanks Morse.
Because all the light plants in the nation,
Don't work the same as this new station.
So all in all from you to me,
I like this man called "number three."

(Written Jan., 1945)

Four years have passed, and a little more,
With one more man we now have four.
This man relieves, three, two and one,
Three days per week he, the engines run.
With this new man things work out fine,
The last three days he works on the line.
Three years have passed and that's enough,
To prove that "one" was only bluff.
To prove that number two has brains.
And never of the rest complains.
And number three to end this story,
Has done his job with skill and glory.

The Boiler Fireman's Handbook

By J. R. DARNELL

The ten most important points in hand firing . . . Cleaning fires . . . Smoke prevention . . . What is smoke? . . . Smoke as related to the type of fuel . . . Anti-smoke ordinances . . . Draft requirements for various rates of coal consumption

XI. Hand Firing Methods for Solid Fuels

IN THIS and subsequent chapters we will discuss methods of firing solid, liquid and gaseous fuels. Under the classification of solid fuels such as coal, coke, lignite and wood we will discuss hand firing, various types of stoker operations, and pulverized fuel firing. However, since our space is limited, we will not discuss details of those particular phases of firing which are well known and which may be obtained from other handbooks[1] or bulletins such as those published by the United States Bureau of Mines.[2]

Instructions for hand firing are generally directed to the use of soft coal but the most approved methods of handling the scoop, the slice bar and other tools apply generally to any kind of solid fuel.

Having had some experience in coaching athletic teams, the author believes that we may paraphrase the statement that "a good athlete is born, not made" by stating that this applies equally well to firemen. If a baseball player is batting .375 a good coach will not attempt to change his stance no matter how awkward or unorthodox it may appear. In like manner, the author has known excellent firemen whose stance did not conform to textbook directions but who, nevertheless, kept up the steam pressure and consistently maintained CO_2 readings from 12 to 14 per cent.

The ten most important points to observe in hand firing are:

1. Fire in small quantities and at short intervals using the alternate firing method. Spread the coal over the rear half section of the grate through door No. 1 and the front half section through door No. 2 on the first round and reverse the operation on the second round.

2. Keep thin spots covered but don't scatter the coal too thin. Use coarse coal for spots which are almost down to the grate and finer coal for spots not so thin.

3. Keep the fuel bed from 4 to 10 in. thick. The more frequent the firing intervals, the thinner you can keep the fuel bed and still have high CO_2.

4. Use blue goggles or have a blue transparent visor on your cap in order to clearly see holes in the fuel bed.

5. Don't disturb the fuel bed any more than necessary to remove clinker. The more you agitate the fuel bed, the more clinker you make if you are firing coal with low fusion point ash. See Chapter VI.

6. Keep the ash pit doors open.

7. Regulate the draft with the damper. There should be a separate damper for each boiler, the damper being provided with means for control from the front of the boiler.

8. A draft gauge should be provided to control the amount of draft. See Chapter X.

9. A large quantity of air should be admitted over the fire during each firing period and immediately after. For high volatile coals and wood it may be necessary to turn on steam or air jets or provide over-fire air by means of a blower. Quick opening steam or air valves for over-fire jets synchronized with the opening of the fire doors may be provided.

10. A smoke indicator or recorder should be provided. If you can't get the management to install one, keep an eye on the chimney, either directly or by means of a mirror. Of course, if the plant operates at night the fireman won't be able to see the top of the chimney without a flood light which probably will cost as much as a smoke indicator or recorder.

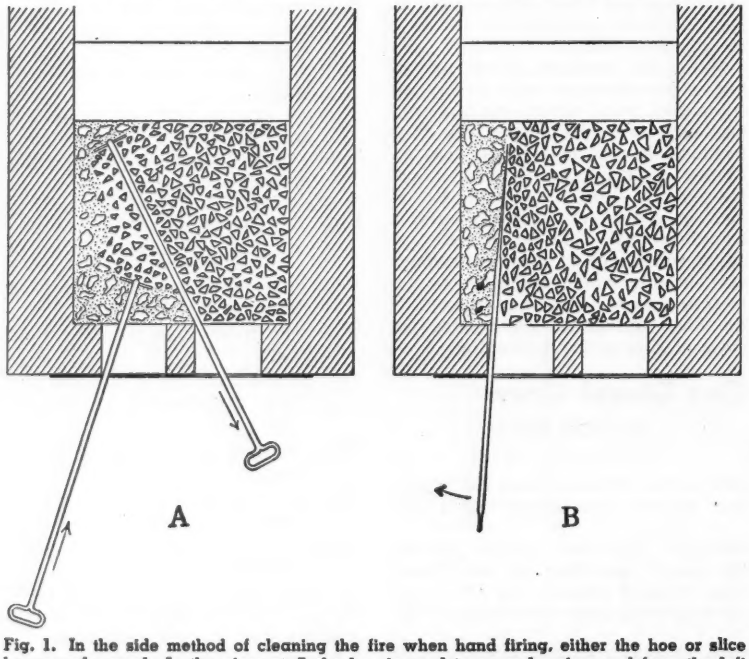


Fig. 1. In the side method of cleaning the fire when hand firing, either the hoe or slice bar may be used. In the view at A the hoe is used to move burning coal from the left to right side of the grate. If the slice bar is used, its motion should be shown at B

Cleaning Fires

As mentioned in instruction No. 5 and fully explained in Chapter VI, clinker is fused ash. If the fuel bed is disturbed, ash in the relatively cool zone near the grate will be brought up into the high temperature zone at or near the surface of the fuel bed where it will fuse and form clinker. For coals with low fusion point ash, some clinker formation is unavoidable but such clinker must be removed periodically. This operation is commonly called "cleaning fires" and if possible, should be performed when the load is light.

There are two methods of cleaning, the side method as shown by Fig. 1 and the front-to-rear method shown in Fig. 2. In the former method as described by the Bureau of Mines, burning coal is raked to one side and the clinker then pulled out through the fire door.

In the second method the burning coal is pushed to the rear and the clinker in the front is then pulled out through the fire door. The Bureau of Mines states that the second method is not as thorough as the side cleaning method. But whatever method is used the fireman should be careful to disturb the ash next to the grate surface as little as possible.

[1] Finding and Stopping Waste in Modern Boiler Rooms. Publication No. 1600, Cochrane Corp. (1928).

[2] Hand Firing Soft Coal Under Power Plant Boilers, United States Bureau of Mines Technical Paper No. 80.

Smoke Prevention

Instructions 9 and 10 deal with smoke prevention since excessive smoke production is the great bugaboo of hand firing. Much of the smoke resulting from hand firing could be eliminated if the furnace were equipped with means for supplying over-fire air, particularly if this air could be preheated. Since the installation of an air preheater might not be physically possible or might be too expensive, some of the beneficial effects of preheated air might be realized if the furnace were supplied with hollow walls through which air could be forced and discharged through ports in the front wall. One concern supplies special refractory blocks which discharge jets of air downwardly on an angle as shown in Fig. 3.

If the management does not wish to go to the expense of providing hollow walls in order to obtain heated air, the simplest and least expensive expedient is to install in the front wall, cast iron pipes with bell shaped outer openings. Steam or air jets are centered in these openings as shown in Fig. 4.

These pipes should be placed on 12 in. centers, 8 in. from each side wall at points about 12 in. above the grate, with the inner openings pointing to the top of the bridge wall. For smaller boilers, there should be one—2 in. pipe for each 250 sq ft of boiler heating surface. For larger boilers these cast iron pipes may be of 3 in. diameter. The flared outer openings for the 2 in. pipes should be about 3 in. diameter and for the 3 in. pipes they should be about 4½ in. diameter. The steam jets should have brass nozzles of 3/32 in. diameter for 2 in. pipes and ⅛ in. diameter for 3 in. pipes. The steam jets should be exactly centered in the openings in the wall and about 1½ to 2 in. back. For best results the steam pressure should be 100 lb psi or over.

Admission of steam or air to these jets can be so arranged that when the fire doors are opened the steam will be turned on. If electrically controlled valves are provided, a time delay relay can be installed in the circuit so that steam will continue to flow through the nozzles for several minutes after firing.

Aside from its nuisance, the formation of smoke means the loss of valuable fuel and any fireman who can keep up steam without making smoke will save his employers considerable money.

Inquisitive firemen often ask: "What is smoke?" or "How can smoke be consumed?" Answering the latter question first, we may say unequivocally that under ordinary conditions smoke cannot be consumed, if it is once formed but its formation *can be prevented.* The design of the furnace and the type of fuel burning equipment is directly responsible for the appearance or absence of smoke.

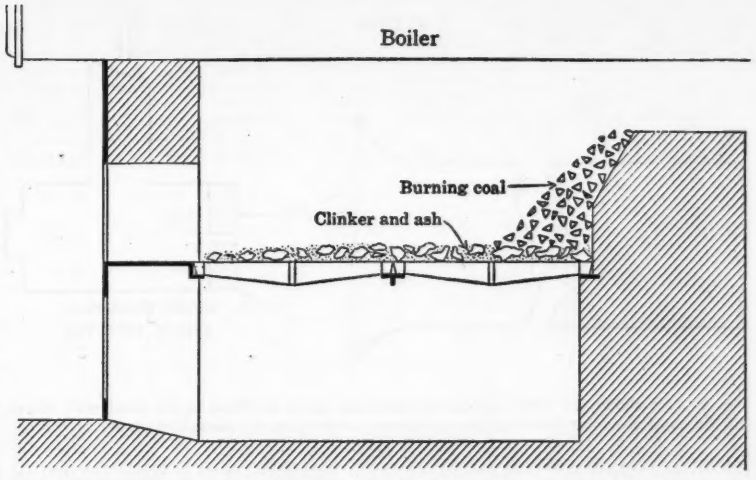


Fig. 2. This shows how the burning coal is pushed to the rear in the front-to-rear method of cleaning, leaving the clinker in front, ready to be pulled out

Before attempting to discuss the prevention of smoke we should first have a clear definition of smoke and what causes it. Smoke is an appreciable, visible volume of finely divided particles of carbon together with other products of combustion appearing in the atmosphere. When found alone, the fine particles of carbon are called soot.

Most solid fuels, particularly coal, may be considered as having its chemical constituents divided into four parts, namely: moisture, volatile matter, fixed carbon and ash. Incomplete combustion or in some cases, non-combustion of some of the volatile matter is directly responsible for smoke.

Bituminous or soft coals have higher percentages of volatile matter than anthracite or hard coal. Soft coals, therefore, smoke more readily than anthracite but can be made practically smokeless by processing in coke ovens. Since most of the volatile matter is driven off in the coking process, the coke thus formed can be burned with little or no smoke with much less combustion space than required for soft coal. With respect only to smokeless firing, coke is the ideal solid fuel and probably would be in universal demand if it were not for the high prices demanded by the gas companies and other manufacturers of by-product coke.

Pocahontas, Georges Creek, New River and other low-volatile Eastern bituminous coals have considerably less volatile matter than misdwestern coals such as Illinois, Indiana and Western Kentucky, and therefore, have less tendency to form smoke. But here again the higher price except in local markets is a deterrent to general usage.

Many large cities have anti-smoke ordinances prohibiting the emission of dense smoke from chimneys, except for short periods when fires are being cleaned. Dense smoke usually is considered as being equal to or greater than number three of the Ringlemann smoke charts.

In the city of Chicago the period of permissable emission shall not exceed 6 minutes in any one hour. There is, however, a section of the ordinance which might be so interpreted by the smoke inspectors, that continued period of emission, even through less than the time limit, are violations and subject to penalty.

This section reads as follows: "Any person or persons, firm or corporation causing, permitting or allowing the escape from any smoke stack or chimney into the open air of such quantities of ash dust, soot, cinders, acid or other fumes, dirt or other material or noxious gases, in such place or manner as to cause injury, detriment, nuisance or annoyance to any person or persons, or to the public or to endanger the comfort and repose, health or safety of any such person or persons or the public or in such a manner as to cause or have a natural tendency to cause injpry or damage to business or property, shall be deemed guilty of a violation of this section and upon conviction thereof shall be fined not less that $10.00 nor more than $100.00 for each offense and each violation of the provision of this section shall constitute a separate offense for each and every day upon which such violation shall continue."

It follows therefore, that even though the emission of smoke is for a

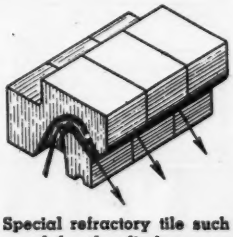


Fig. 3. Special refractory tile such as this may be used for the discharge nozzle for air preheated in hollow walls or by waste gases and injected over the fire in order to help prevent smoke

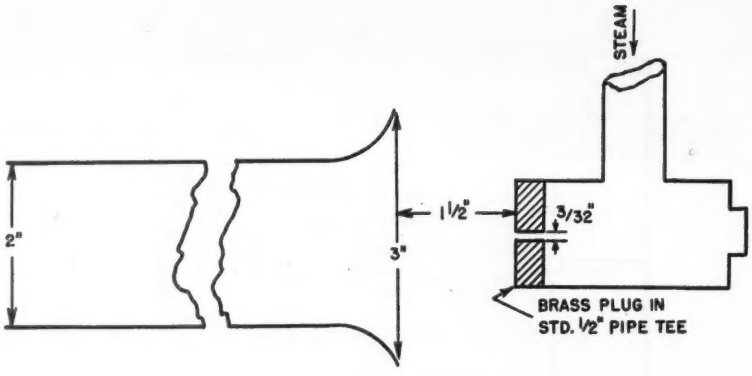


Fig. 4. This shows the shape of special cast-iron pipes installed in the front wall above the fire and used for injecting air for smoke prevention by means of steam or air jets

period less than six minutes in any hour, if there should be a continuity of such periods in succeeding hours, the accumulation of smoke and noxious gases might be construed as detrimental to comfort and repose or health and safety of persons residing or working in the vicinity.

The safest and withal, the cheapest course for owners and operators of fuel burning equipment is to not make smoke in any appreciable quantity.

It is probably safe to say that 98 per cent of all smoke violations are from installation with coal firing. Occasionally improper adjustment of oil burners causes smoke while with gas firing, seldom, if ever, is there any complaint of smoke emission. It should be noted, however, that this high percentage of violations from coal firing is largely due to the fact that the great majority of installations burn coal.

At times, smoke is caused by lack of chimney height. In order to provide for adequate draft for various rates of coal burning, the City of Chicago has the following regulation:

"For rates of fuel consumption up to 24 lb coal per square foot of grate surface per hour the draft over the fire measured by standard draft gage in inches of water shall be 0.01-in. per pound of coal burned per square foot of grate surface per hour.

For rates of combustion above 25 lb of coal per square foot of grate surface per hour the following over fire draft shall be provided:

Coal per sq. ft of grate surface:

30 lb per hr.....0.33 in. of water
35 lb per hr.....0.40 in. of water
37 lb per hr.....0.45 in. of water
40 lb per hr.....0.50 in. of water
45 lb per hr.....0.60 in. of water

Figure 5 shows the proper locations for draft gauge connections for an HRT boiler but the location for the connection for over-fire draft will apply equally well to any kind of boiler furnace and for any kind of firing method.

In order to keep a check on the combustion rates being maintained, firemen should make periodic checks on the weight of coal fired per hour. If no scales are available the density of the particular coal being fired can be determined by having a local grocery weigh a 10 or 12 qt bucketful and then calculate the weight of a cubic foot. A 12 qt bucket contains approximately 0.4 cu ft. If the net contents of the bucket weighs 22 lb then the coal weighs 55 lb per cu ft. Next, make up a bin from close fitting boards, say, 4 ft square and 3 ft deep with a sliding door 2 ft wide. When the bin is level full it will hold 48 cu ft and if the check on the bucketful shows a density of 55 lb per cu ft then the bin will hold 2640 lb. The next step is to keep a check on the length of time required to empty the bin and then calculate how much coal was fired per hour.

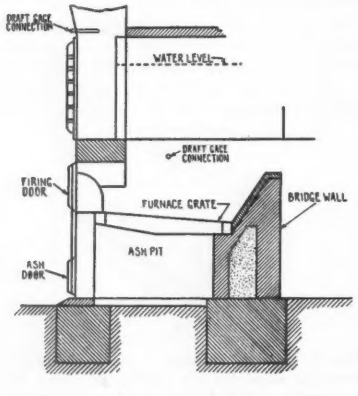


Fig. 5. Here are the proper locations for draft gauge connections

Boiler Water Analysis Detects Leak in a Hot Water Heater

By John F. Slavinsky

IN THE PLANT I work in we operate a 60,000 lb per hr steam generator and the feedwater is chemically treated. We make daily tests for alkalinity sulphates, chlorides, etc.

In the system we use, our chlorides must be kept less than 200 ppm. The daily average tests run about 90 ppm to 150 ppm of chlorides.

The feedwater is bought from a local water company which has a chloride content of 10 ppm. This water is run through a zeolite water softener, then pumped into a storage tank through a float operated valve. The mill returns are also pumped into the same tank.

The rest of the plant uses well water which is supplied by six deep well pumps, pumping about 300 gpm. In the mill we have two hot water tanks which are heated by the exhaust steam through a bank of copper tubes. The condensed steam is pumped by a vacuum pump into the storage tank. We are using up almost all the process steam in our boiler. The bought water is used as needed, when we don't get enough condensate returns, also making up for the loss of water in our continuous blow down line. We have about a 4 per cent continuous blow down loss which is necessary to get rid of suspended matter in our boiler drum.

The well water is very hard and the chlorides average about 200 ppm. Recently while making a boiler water test for chlorides we found that the chloride content of the boiler water was beyond the maximum recommended limits.

We immediately took samples of all condensate returns and tested them. By this method we were able to detect where the hard water was coming from. We traced it to the hot water heater. After putting a test on the heater we found about a dozen tubes that were leaking. After making repairs to the hot water heater the boiler water chloride content returned to normal.

This article should stress the importance of daily boiler water analysis.

Circuit Breakers and Switches

WHEN OPENING enclosed type circuit breakers and line switches make certain by examination that they are really open. The writer has seen an instance when a two-pole circuit breaker was tripped for the purpose of examining a 40 hp motor. Upon examination it was found that only one pole of the breaker had opened; the other pole contacts were welded together. Had this fact not been discovered before examining the motor, a serious accident might have occurred since one side of the line to the motor was still connected.

The writer also recalls an occasion where a two-pole enclosed line switch was opened, but upon inspection it was discovered that the insulating bar connecting the two poles of the switch together had disintegrated (the switch was mounted outside in the weather) thus failing to completely open the switch contacts.

AREA OF LEAK	AIR		STEAM		WATER	
Diameter Inches	Number of cubic feet per month at 75 lb. pressure	Total cost of waste per month 11c per 1000 cubic feet	Pounds wasted per month at 160 lb. pressure	Total cost of waste per month 65c per 1000 lb.	Gallons wasted per month at 60 lb. pressure	Total cost of waste per month 16c per 1000 gallons
1/2"	13,468,000	$1,481.44	1,219,280	$792.53	1,524,100	$243.86
3/8"	7,558,500	831.44	684,290	444.79	855,360	136.86
1/4"	3,366,990	370.37	304,820	198.13	381,020	60.96
1/8"	824,570	90.70	74,650	48.52	93,310	14.93
1/16"	213,000	23.43	19,280	12.53	24,110	3.86
1/32"	52,910	5.82	4,790	3.11	5,990	.96

What does it cost you each month

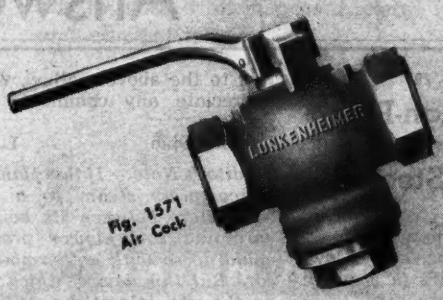
... for air, steam, water, you never use?

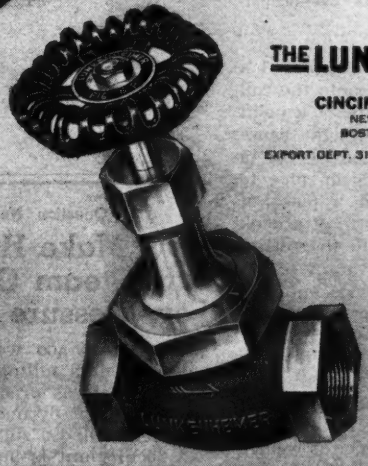
Maybe you've never checked the actual cost of valve leakage. If you haven't, you'll doubtless be startled at these figures.

A single valve leak the size of a pinhead can waste enough air in a month to approximate the cost of a new valve. Steam leaks... water leaks... also take a heavy toll if neglected... not to mention the wastage of such a critical item as fuel.

Where Lunkenheimer Valves are given ordinary care, such losses are held to an absolute minimum. These quality-built valves are designed to give extra long service with the lowest possible outlay of time, labor, and money, for maintenance.

Enlarged copies of the above chart for posting in your plant are available on request. Also available are the services of your nearby Lunkenheimer Distributor, who is fully equipped to assist in solution of your operating or maintenance problems.





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LETTERS AND COMMENTS

Over-Temperature Alarm

ANSWERING the query of the hotel engineer in the April issue, page 93, I assume that the faulty operation of his refrigeration system permitted the temperature in his meat storage room to rise above the safe point and he lost his meat because the room got too warm. His manner of stating the problem, however, is ambiguous since he speaks of "the ice machine running below temperature" and "the system froze up." If it literally "froze up" I don't see how the meat could spoil since I never heard of frozen meat spoiling.

However, if the system ran at over-temperature the solution to the problem is simple. As shown by Fig. 1 a device could be clamped onto the coil circulating the refrigerant at a point where faulty operation might cause damage. This device consists of a short nipple of ½ or ¾ in. pipe to which has been welded a piece of strap iron bent in the form of a hook which can be clamped to the refrigerant coil by means of a set screw. Before clamping the device onto the coil, a disc of low temperature (eutectic mixture) fusible alloy, or wax, or even a disc of molded ice, through any of which there is a small hole, is inserted in the lower end of the pipe nipple. A piece of flexible wire with a small flat disc which is welded or soldered onto one end of the wire, is threaded through the disc of fusible or easily melted material and then connected to a spring operated switch which will ring a bell or cause a light to flash on or operate both of these signals.

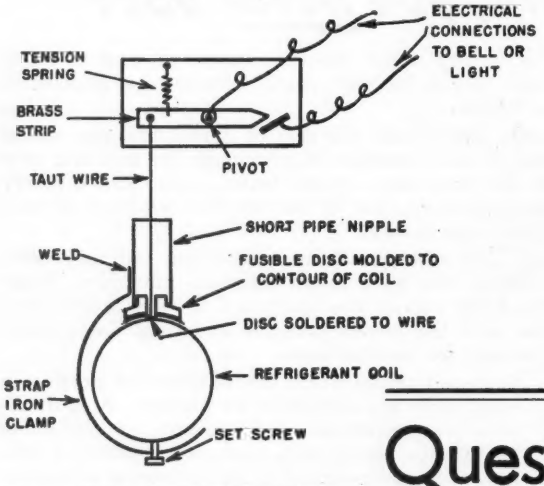

Fig. 1. Simple, home-made over-temperature alarm

If the temperature of the refrigerant coil rises high enough to melt the wax or the ice, the tension on the wire is released and the spring on the switch will close the electric circuit and ring the bell or turn on a light.

Figure 2 shows a modification of Fig. 1 in which the wire under tension between the fusible plug and the electric switch, is connected to a flat spring above which is mounted a mercury switch which makes the electrical contact when the glass receptacle containing the mercury is tilted.

Naperville, Ill. J. R. DARNELL

Correction

Attention is directed to an error in the caption to the illustration on page 114 of the May issue. This caption instead of reading, "Diagram showing layout of condensing water system," should read, "Diagram showing arrangement of boiler plants and steam distribution system."

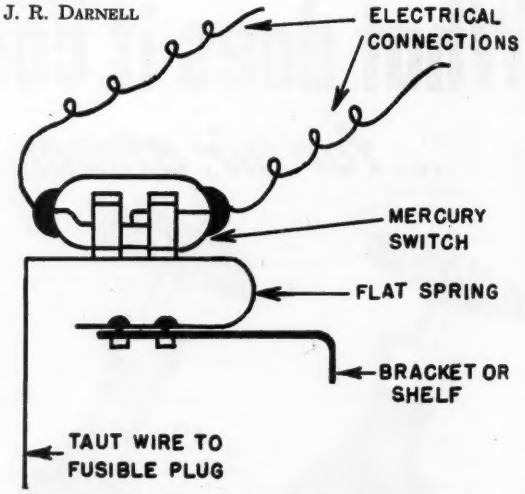

Fig. 2. A modification of the alarm arrangement shown in Fig. 1.

Questions And Answers

Question No. 297

How Make High-Pressure Steam Out of Low-Pressure Steam?

SOME TIME AGO we recall seeing published data telling how high-pressure steam was produced in a low-pressure plant by means of a steam compressor and a superheater.

A local plant is interested in this subject, as they have a very small high-pressure steam requirement, as compared to a 150-hp heating requirement.

If Q & A readers know of any economical way of producing high pressure steam for this purpose, in addition to the above method, we would appreciate any comments or suggestions.

Canton, Ohio L. C. D.

Editor's Note:—If this plant wanted to compress steam to a pressure somewhere between its boiler pressure and some lower pressure, it could do so with a thermo-compressor. But this device, which operates on the principle of the steam jet air pump, would not, so far as we know, produce a pressure above that at which its motive steam is generated.

It seems to us that the simplest, quickest and cheapest way for this plant to obtain a small amount of high-pressure steam would be to generate it directly from burning

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fuel. Small capacity, high-pressure steam generating units for this purpose are: the Besler, capable of producing 2500 lb per hr of 2500-psi steam per generating unit; the Vapor-Clarkson unit for capacities of 500 to 3000 lb per hr of 300-psi steam; the Clayton unit, capacity 300 to 4500 lb per hr of 150 psi steam; old high-pressure boilers designed for pressure of 600 to 1000 psi from Doble, Stanley or White steam automobiles. All these small steam generating units were described in detail in Answer No. 253, Q&A section, P. E. & E, August, 1944, pages 98-102.

Question No. 298

What Types of Boilers and Stokers Should They Choose?

WE NEED some additional boiler capacity, approximately 450 or 500 hp to supply steam to our creamery. We haven't definitely decided what would be the better type boiler and stoker to use for this type of steam generation. We burn coal of around 10,000 Btu quality, with a rather high ash content, around 12 per cent.

We are wondering what the opinion of Q & A readers would be in regard to the boilers and stokers we should choose: that is, Scotch Marine, HRT or water-tube boilers and underfeed, spreader type or chain grate stokers. We will appreciate any information you can give us on this.

Indiana O. B.

Question No. 299

What Sucks the Water Out of the Bucket?

WE HAVE two 15-ton horizontal ammonia compressors. We have an evaporative condenser from which we get very good results. The plant is shut down over night and started each morning. Well, when I go to purge air and gases from the evaporative condenser, I run a hose from the purge valve into a bucket of water. Sometimes the gas is purged in this manner very satisfactorily. But at other times I crack the purge valve and, if I don't look out, the water will be sucked from the bucket. Could you tell me what causes this?

Brooklyn, N. Y. J. K. R.

Question No. 300

How Aerate Water to Remove CO_2?

A FEW MONTHS AGO we were treated to an exceptionally good series of sketches in P. E. & E. on feeding acid to boiler feedwater. (This was Problem 33: March, May, June, 1944, issues, P. E. & E.—Ed.)

I wish to feed acid to zeolite-softened water and would appreciate it if these and other engineers would tell us the following:

1. Methods of aerating to remove CO_2 after the acid is added;
2. Capacity of blower or amount of compressed air for aerating a given amount of water;
3. Methods of testing to determine when the CO_2 has been removed and when the water has been properly treated. In my case the water before softening has 17.5 gpg hardness;
4. Best place to introduce the acid;
5. Corrosion troubles to be expected.

Appleton, Wis. M. P.

Aeration is the process of bringing air into contact with water to remove CO_2 and other gases from the water. The process is frequently recommended for removing CO_2 after acid treatment in connection with zeolite water softening systems in power plant water treatment.

It does not replace the use of the deaerating heater to remove CO_2 but instead improves the operation of this heater. When feedwater has a high CO_2 content, either as CO_2 in the raw water or as CO_2 produced during the reactions in the softening process and from the addition of the acid, the deareating heater may not be able to remove the CO_2 completely. This is a result not of any defect in the heater

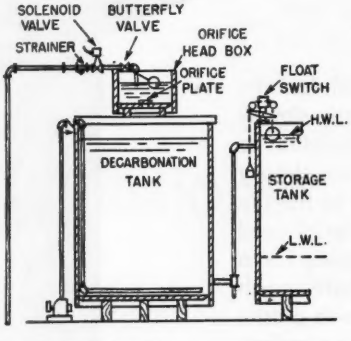

Fig. 1. Decarbonation system using compressed air to aerate water to remove CO_2

but of the relations between the partial vapor pressures in the heater and the release of the CO_2. It is often recommended, therefore, that whenever the feedwater contains more than 25 to 30 ppm of free CO_2, regardless of whether this CO_2 was originally present in the raw water or results from the method of water treatment, the CO_2 content should be reduced to 10 to 15 ppm or less before the water goes to the deaerating heater. This remainder, together with the dissolved oxygen, will then be completely removed by the heater.

The device most commonly used for aerating water to remove CO_2 ahead of the heater is usually known as degasifier, as described below. Other methods have been used, however, and these will be noted first.

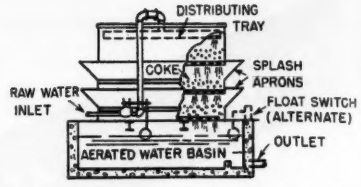

Fig. 2. Steel coke tray aerator for removing CO_2 from water

In general, contact of water and air can be brought about by:

a. Introducing the air into the water.

b. Introducing the water into the air.

The following methods of carrying out both a and b are described in the Water Conditioning Handbook, published by The Permutit Co., from which the illustrations Figs. 1 to 6, were also adapted.

Air may be introduced into water by blowing it through water contained in an open tank, or by blowing the air into water under pressure in a closed tank, which may or may not be vented. Blowing the air through water in an open tank may be done by means of air grids as shown in Fig. 1, the source of the compressed air being a blower or compressor.

The second method of aeration-introducing water into the air—is the most widely employed. The most satisfactory method of doing this is with the degasifier in which the water rains down over a series of slot trays through a controlled counter-current of air. The least efficient device is one in which a short thick stream of water flows through the atmosphere. Other devices range between these extremes.

It has been found that, contrary to some opinion, drops of water do not produce the most efficient aeration for limited travel. On the contrary, it has been found that production of films of water and presentation of fresh surfaces produced by a large number of slats or trays, with very slight falls between them, are most efficient. This idea combined with the use of a controlled counter-current air flow has been used in the degasifier.

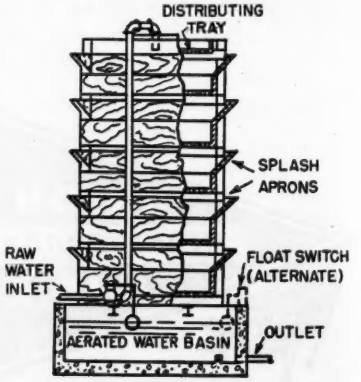

Fig. 3. Wood-slat tray type aerator for removing CO_2 from water

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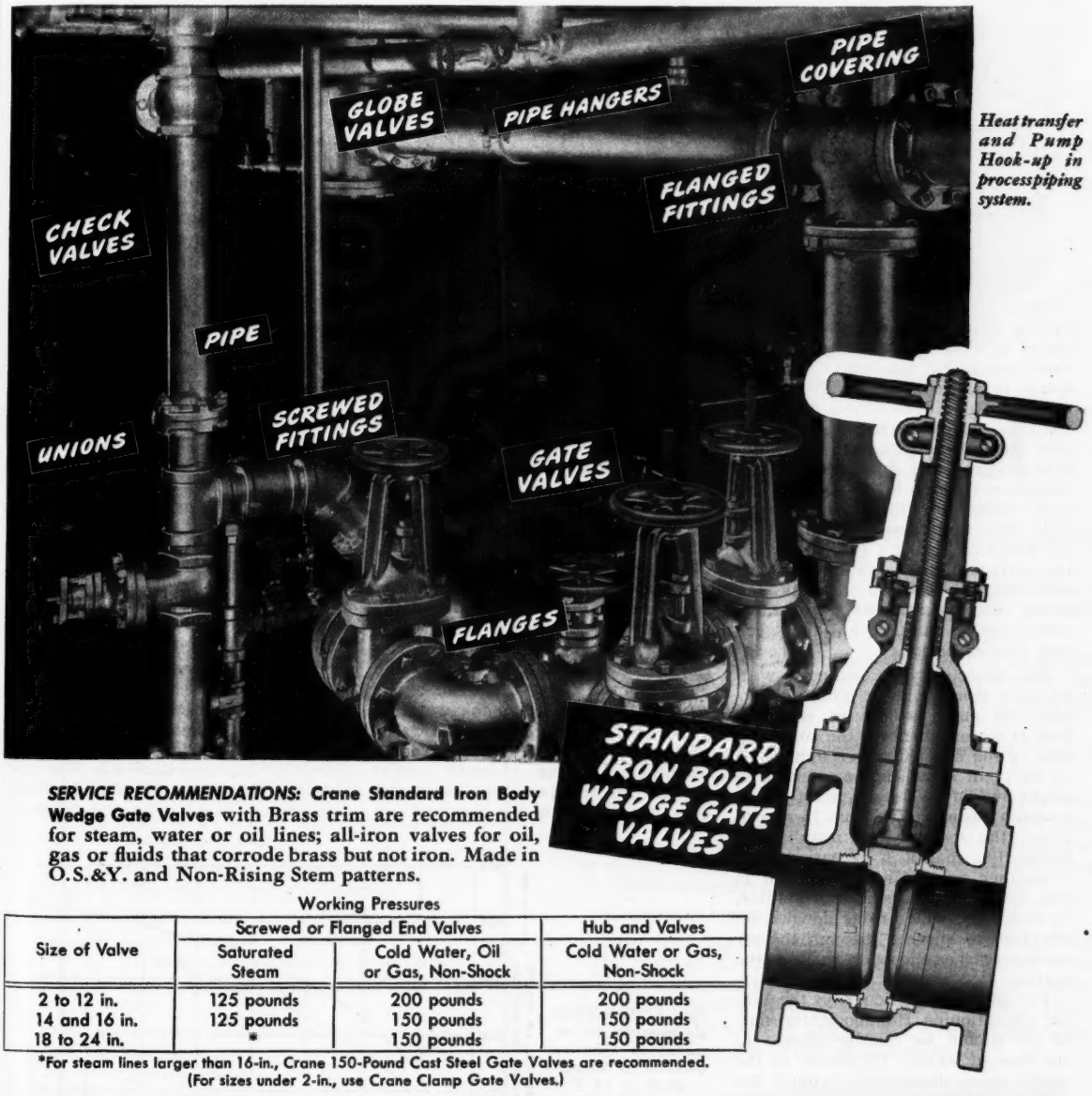

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14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

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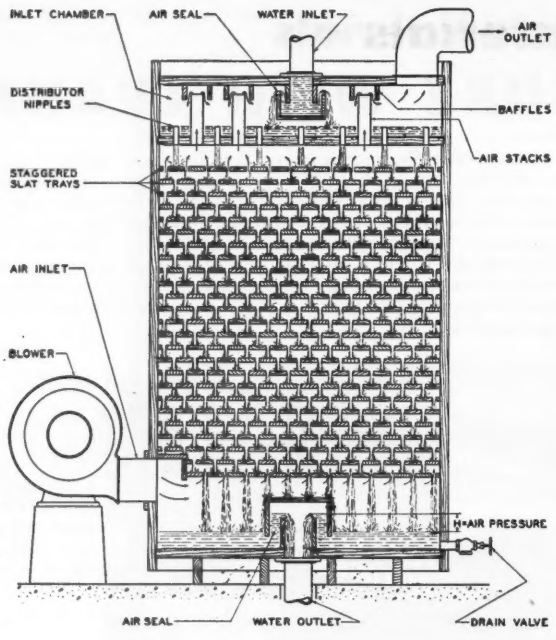

Fig. 4. Degasifier for CO_2 removal from water, showing counterflow of water and air

There is a type of aerator, shown in Fig. 2 in which the water is allowed to flow over louvered structures containing coke trays with air spaces between the trays. The entering raw water flows into a distributing tray, which distributes it evenly over the entire area and then permits it to drop through an air space to the surface of the first layer of coke. The water percolates through the porous coke, then drops from the bottom of the first tray through an air space to the surface of the second tray. This operation is repeated through the series of trays and the water rains down finally through an air space into a catch basin.

The latter may be equipped with an inlet float valve or with a float-operated pump switch to stop the flow of water whenever the consumption of the aerated water diminishes to the point at which the catch basin might overflow. The detention period in catch basins varies from 15 min to 2 hr, the majority of installations having less than a ¾-hr period.

Another type of aerator shown in Fig. 3, is the wood slat tray aerator, in which the water rains down from one tray to another through the air until it reaches the catch basin at the bottom.

For efficient aeration, says the Water Conditioning Handbook, the flow of air should be counter-current to the flow of water. Therefore, as the water rains downward through the aerator, the air should enter the bottom and pass up through the water and emerge at the top. In the open types of aerators shown in Figs. 2 and 3, volumes of air are introduced by natural air circulation and their directions of flow are erratic, being dependent on wind velocities, eddy currents, and relative temperatures of the air and water. Hence there are variations in the degree of aeration, windage losses, and often serious spray problems.

To overcome these difficulties and control the entire operation, the degasifier shown in Fig. 4 has been developed. This employs a controlled and constant flow of air, the direction of which is always counter-current to the flow of water.

A given amount of air brought into intimate contact with water containing, for example, CO_2 in solution, can remove only a certain quantity of the CO_2. For as soon the CO_2 left in solution corresponds to the increased partial pressure of that taken up by the air, no more CO_2 can come out of the solution. Therefore, as the water is being gradually relieved of CO_2, it must be continually exposed to an atmosphere having a lower partial pressure of this gas. Also, rapid and effective removal of the dissolved gas requires that the stream of water be broken up and redivided so as to repeatedly expose a new surface, thus bringing each particle of water into contact with the air. With counterflow, the water giving up its dissolved gas is constantly being exposed to air containing less of this gas. On the other hand, the rising air encounters increasing and more easily removable quantities of the gas.

To accomplish this, the degasifier of Fig. 4 has been developed. It consists of a shell filled with staggered slat trays as shown. Construction is of corrosion-resisting materials. Water is admitted through an air seal into an inlet chamber at the top. This chamber has distributor nipples that distribute the water uniformly without allowing appreciable change in water level in the inlet chamber with variations in flow rate. The water from the distributor nipples cascades over the slat trays, which are staggered so that water from the edge of one tray strikes the middle of the tray below. The water films are thus repeatedly broken up. Water is discharged at the bottom through an air seal. Air from the blower flows from the bottom up through the slat tray openings and out through air stacks in the inlet chamber to the discharge.

Figure 5 shows the theoretical amount of air required with counterflow of air and water to reduce the CO_2 content of the water from any given initial value to the desired final value. The diagram is based on a water temperature of 59 F. Since the solubility of CO_2 in water varies with the temperature, becoming zero at 212 F, the air ratio as determined in Fig. 5 must be corrected by multiplication by a factor determined from the temperature correction curve of Fig. 6.

If compressed air were to be used for aeration the amount required as shown by Fig. 5 could be calculated from the table Discharge of Air Through an Orifice, page 114, Compressed Air Data, Fifth Edition, published by Ingersoll-Rand Co. For example, with a ½-in. orifice and an air pressure of 70 psi gage, the theoret-

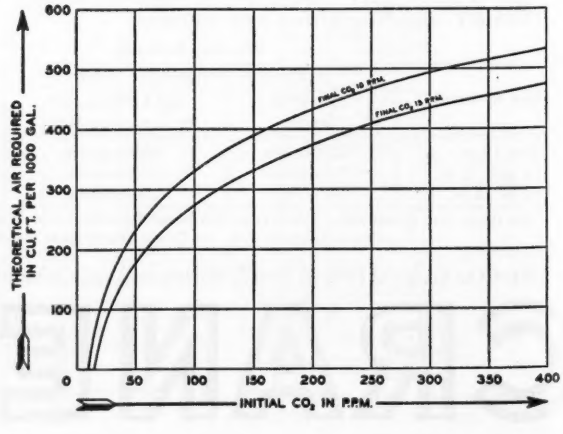

Fig. 5. Theoretical air required for removal of CO_2 by aeration at temperature of 59 F

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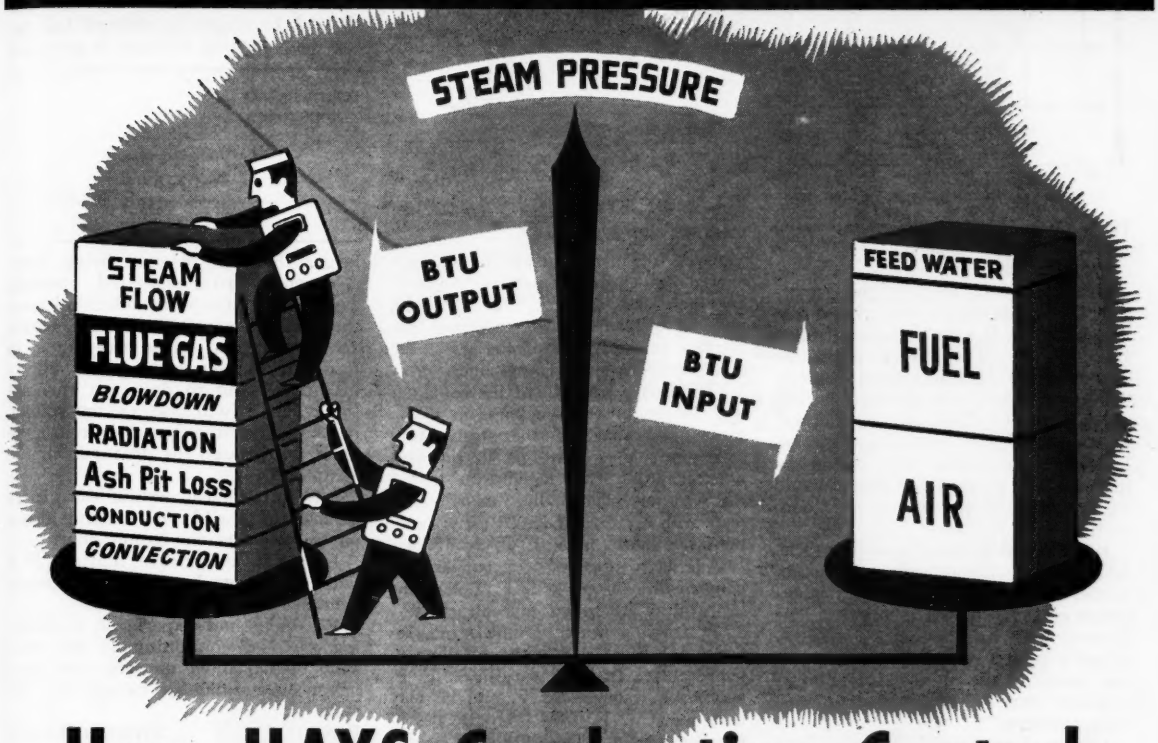

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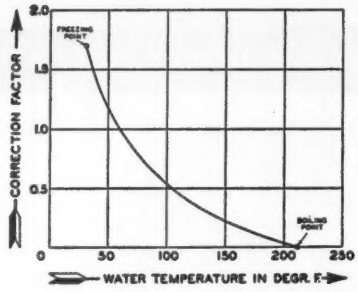

Fig. 6. Temperature correction factors for Fig. 5

ical discharge of air into the atmosphere would be about 300 cfm of free air. This would have to be multiplied by 0.97 for well-rounded entrances and 0.65 for sharp-edged orifices. These are not exact calculations but given merely to indicate the method. Furthermore, the compressed air velocity at the nozzle exit would be high and in a degasifier there would be problems in distributing and controlling it.

With the degasifier shown in Fig. 4, standard sizes of unit can be obtained ranging from 53 gpm maximum capacity up to 5500 gpm. The blower and its driving motor are either supplied with the degasifier or the sizes of the motor and blower capacity can be obtained from the manufacturer.

In regard to methods of water testing, some detailed instructions from Urban C. Fleming, Jr., Chemist, City of Holyoke Gas & Electric Dept., and from E. O. Davis of Chicago, are being prepared for publication in an early issue.

Answer No. 275

What Is P-T Relation at Freezing Point of Water?

THE ONLY INFORMATION I have handy says that under 130,000 psi, 16 volumes of water will be reduced to 15. In freezing, water expands to 1,0855 times its volume.

Assuming the resiliency of the most minute particles of which water is composed will remain the same whether the water is in a liquid state or a solid state, we may calculate:

$$\frac{1 - \frac{1}{1.0855}}{\frac{15}{1 - \frac{16}{}}} \times 130{,}000 = 163{,}800 \text{ psi}$$

roughly the pressure required to reduce ice to its liquid volume. This 163,800 psi would be the pressure inside W. E. P.'s container after the water had frozen, provided the steel did not give.

I have not handy information on the tensile elasticity of steel. If W. E. P. wants to know roughly what pressure will be reached in his container he may look up what percentage of its original length steel will stretch and return to its original length, supply the information in the following equation, and solve for the unknown, letting X equal pressure reached in psi:

$$0.0855 \left\{ \frac{X}{\text{tensile strength container in psi}} \times \frac{\text{elasticity of container}}{} \right\}$$

$$X = \frac{}{0.0855} \times 163{,}800$$

He will understand that X may not exceed the tensile strength of container, for the elastic limit will be exceeded, and the tension will decrease with the increase in expansion of the water beyond the container's elastic limit.

The tensile strength of the container will be roughly the thickness in inches times the rating of the steel. More closely calculated, it will be Outside volume cu in.—Inside volume cu in. × tensile rating. Incidentally, 3 in. of boilerplate with a rating of 55,000 psi is about the inside limit for W. E. P.'s container. It has been assumed the temperature will remain constant at 32 F. Below this temperature ice begins to contract.

In freezing, water, I understand, releases 143 Btu per lb without falling in temperature. In other words, W. E. P. may have water at 32 F, and he may have ice at 32 F. The difference lies in the Btu content. This is known as the latent heat of fusion. It is called latent because its presence is imperceptible.

It is my idea that the most minute particles of which water is composed in the liquid state are constantly in circulation. The latent heat of fusion is contained in the momentum of these minute particles and amounts to:

143 Btu × 778 ft lb per Btu=110.254 ft lb momentum in one pound of water at 32 F.

Freezing is an arresting of these minute particles. It is possible that when their traffic falls below the speed maintained at 32 F it jams. The resulting exchange of momentum is measured in units of heat, the statistics of which have already been given, 110,254 ft lb per lb of water.

In this arresting process, the water particles, like bricks in a barrel, come to a stop in awkward positions not making for the most economical utilization of space. The wastage of space is probably not uniform for each particle, but for the bulk a definite average is maintained. The temperature does not change in the process. But the bulk expands by 0.0855 times its liquid volume.

Omaha, Neb. PAUL WEFELMEYER

Answer No. 287

How Stop Trouble from Sand in Wood Fuel?

He Burns Sawdust Containing 75% Sand Without Difficulty

TO ELIMINATE this trouble several things can be done. First, J. J. P. ought to obtain special grates with approximately 1-in. openings, to provide ample space for the sand to drop out of the wood into the ash pit. Second, he ought to increase the firing door opening at least 75 per cent larger than the original firing door.

Through this increased opening, overfire air should be admitted over the fire. This would produce better combustion and cause the flame to burn down closer to the grates, allowing more sand to drop out through the grates. It will also prevent smoke. At the same time it will decrease the draft up through the grates from the ashpit.

I would suggest setting the grates as low as possible and cutting down on the draft at the ashpit door.

It will also improve matters if a Dutch oven can be added to increase combustion space.

We have had experience in burning sawdust containing 75 per cent sand by the above methods and have never had difficulty caused by the sand.

Brooklyn, N. Y. STEPHEN KULICH

Answer No. 291

Help Wanted on Lubrication and Inspection Schedules

Log Book and Card File Systems

IN REPLY TO your question on lubrication and inspection schedules—which is an interesting and important part of any plant's operation to keep track of the motor records—we have tried several methods but find the log book or file card method the easiest and most complete. Either one can be used separate from the other, or together if wanted.

If the log book method is used, merely reserve a page for each motor, its number, location, etc. If the log book is used in conjunction with the card file system each page of your book should correspond to its file number, for an easy check one with the other, if any information is needed.

The file card system can also be used separately with each motor number, location, etc., on the cards. For easy reference each department or section of the plant can be divided up and each motor listed in that section; as an example—Section A, motor number, location, etc. In this way, a record can be kept of any number of motors and inspection and lubrication records can be listed as completed.

Westwood, Calif. R. G. SUNDQUIST

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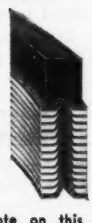
Installed with its reinforcing ring, the "SR" gasket is your guarantee against leaks and blowouts under pressures up to 2500 pounds.

"SR" series are available for standard or non-standard fittings. Your service requirements and specifications determine the number of metal and asbestos spiral turns per diameter in each gasket. The gasket is readily removable from the reinforcing ring for replacement.



★"THE STORY BEHIND THE GASKET THAT BREATHES"

Note on this cutaway drawing, the small air space under each U-groove in the metal ply.

There are twin strips of asbestos filler between each spiral thickness in the AJAX Gasket which cannot meet in the center under the wedge-like groove. Therefore a "breather-space" is preserved in the heart of the gasket which assures its automatic reaction to mechanical compression, to internal pressure variation, and to temperature changes.

The AJAX Gasket expands and contracts — "breathes" — with changing pressure conditions — and retains the positive, secure seal you require at all times.

The above cutaway is the AJAX SR Compression Gauge Flange Gasket

Write today for complete AJAX data—available in Catalog 202

U. S. GASKET CO.

1596 PIERCE AVENUE, CAMDEN, NEW JERSEY

Distributors
IN PRINCIPAL CITIES
A few choice industrial territories are open

Oil Chart for Every Motor

IN ANSWER to W. E.'s question here is the system we have adopted here at our plant. We have many, many times the 250 motors that W.E. has.

Before any motor leaves the repair shop or any new motor is installed, one of the enclosed tags, Fig. 1, is tied to it. This reminds the electrician that installs the motor to make a final check for oil before starting the equipment. He fills out the tag and returns it to the Electrical Office for the district, where the tag is filed according to the building the motor was installed in. This way we have eliminated burning up bearings, because everyone though the other man oiled the motor before it was installed or reinstalled.

Fig. 1. This tag on every new or repaired motor reminds electrician to check oil

Also inclosed is the oil chart form Fig. 2, that we use and rely on. There is a chart for every motor in the plant. These charts are used by the oilers and signed by them as well as by the foreman in charge of the district. These charts are kept on file in the chief's office and are filed as follows. They are made to fit a Standard Notebook and are used thus:

All motors to be oiled weekly are filed in the Weekly Book according to building, those to be oiled monthly in the Monthly Book, etc. This system has been in effect for some time now and proves very satisfactory. It makes each oiler directly responsible for the motors in his district and shows just what he has done. This is very handy if he should be absent from work and someone is assigned to replace him.

Once this system is set up there is no trouble in keeping it up and all the information as to oiling is at the Chief's fingertips. This chart system also causes the oiler to realize the responsibility of his job and causes him to take an interest in it.

ROBERT P. DEANTHONY
Dayton, Ohio

Answer No. 292

How Divide Load Between Two Synchronous Converters?

Must Study Several Factors, Says von Dannenberg

THE WRITER interprets the question as essentially one of operating needs, i.e., making the two converters operate satisfactorily in parallel sharing "proper share of the load" rather than one of "per cent of efficiency" . . . in its strict interpretation.

The details indicated in the wiring diagram show conventional and correct installation, so far as the general connections are concerned. Since only some general information about operating trouble is given, it is in order to inquire whether the two units have operated together in parallel satisfactorily in the past or is the present situation one of recent development. The period given—"3 or 4 hr"—before operating difficulties begin, might at once indicate the building up of some disturbing factor in either or both converters. The questioner states "one machine or the other will begin to carry more load than it should have," but does not state whether the load shifts from one to the other unit in swings, or whether it remains steady or settles down to a fixed relation out of proportion to the capacities.

The study of load division is affected by many variable elements, so as to make it necessary to conduct a systematic study and make changes with great care. Some of the features to be checked are:

1. Check the transformer's ratios at no load and be sure the converters have the same voltage with equal power factors.

2. The series field shunts should be adjusted to give as close an agreement as possible in the slope of the variation of voltage d-c with load.

3. The length of the a-c leads from the transformer terminals to the converters should have the same reactance volt drop throughout the range of load. If this is not practicable, the series field of the unit with the lower reactance should be made stronger by increasing the shunt resistance.

4. The resistance of the series fields, which includes their shunts, together with the resistances of the cables from these fields to the main bus, can be adjusted in inverse proportion to the rated capacities of the converters.

To summarize, correct load division with equal power factor is only possible with adjustment of the relations outlined and may require considerable testing. Possibly the manufacturer can give the quickest aid if all the factors concerned are presented. Even some loose connections, through vibration when heated, will give erratic performance.

It is possible to control the load division between synchronous converters by adding an induction type regulator, usually between the transformer and the machine. Increasing or decreasing a-c voltage will change the d-c load accordingly. It can also be accomplished with less exactness by inserting a variable reactor arranged with a series of taps which can be operated like the tap changer of a transformer. Either of the foregoing methods leads to some expense and complication.

Where the load conditions remain reasonably within limits, it is possible to vary the a-c lead reactance in a simple and inexpensive way by adding laminated ring sections which can be slipped over the a-c leads until the proper load division is obtained. These ring sections are found in use in connection with low voltage a-c network systems and are used to balance the loads or adjust them between transformer banks. The advantage of this remedy is the ease with which the adjustments can be made to suit changing conditions.

C. O. VON DANNENBERG
Brooklyn, N. Y.

NEGLECTING A MOTOR IS SABOTAGING A MOTOR

EQUIPMENT LUBRICATION DATA SHEET

LOCATION— MACHINE DRIVEN—

H. P. VOLTS DUTY SERIAL NO. K. W. KVA.

HOT COLD NORM.

TYPE OF LUBRICATION TEMP. RATING ROOM TEMP.

TYPE OF BEARING: BALL ROLLER SLEEVE CONDITION

REMARKS—

MONTH	DAY	YEAR	GRADE OIL					GRADE GREASE				LUBE		SERVICED BY
			10	20	30	40	X	L	M	H	HR	CH'G'D.	CH'G'D.	

SIGNED—

Fig. 2. Oil chart form like this is used for every motor in plant

One of 3-2" Copes Type RG-2 Feed Water Regulators installed on oil and gas fired units of 43,000 lbs. per hour capacity. A differential pressure control is combined with the feed control valve.

"PERFORMANCE CAN'T BE BEAT— THEY NEVER LET YOU DOWN"

That's THE EXPRESSED OPINION of a Chief Engineer concerning his Copes Feed Water Regulators. It typifies the experience of Copes users everywhere, who have grown accustomed to effective, dependable feed water control.

Reasons why Copes Regulators perform exceptionally well, are:-

(1) Fully Automatic continuous feed in accordance with demand.

(2) Utilization of the simplest principle without mechanical complications. Few parts—all sturdy.

(3) Positive response to level changes 5 to 8 times faster than other devices. No perceptible lag.

(4) Overwhelming ratio of power to friction.

(5) Most closely balanced valve plungers made—no "chatter" or "jumping".

(6) Port areas individually designed for the installation. No over— or under-sizing.

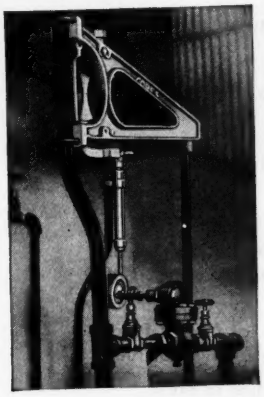
These features, plus others, assure the Copes user of a big return on a small investment. Full details in Catalog 12-44, sent promptly upon request.

NORTHERN EQUIPMENT CO • 652 Grove Drive, Erie, Pa.

FEED WATER REGULATORS • PUMP GOVERNORS • DIFFERENTIAL VALVES
LIQUID LEVEL CONTROLS • REDUCING VALVES AND DESUPERHEATERS

BRANCH PLANTS IN CANADA AND ENGLAND **REPRESENTATIVES EVERYWHERE**

FOR SMALL BOILERS



On small boilers at moderate ratings and pressures, the COPES Type OT quickly pays for itself with correct, continuous feed that means more steam per pound of fuel. Makes operation safer by stabilizing water level. Fully-automatic, it saves time for operators.

☆ *For* **SAFETY** *and* **ECONOMY** *Specify*

COPES

HEAT BALANCE FOR OIL OR COAL

1. Heat absorbed generating steam

$$\text{(boiler efficiency) per cent} = \frac{W \times (H_s - h_F) \times 100}{F \times B}$$

2. Heat loss in dry chimney gases, per cent $= \dfrac{G \times 0.24\,(T - t) \times 100}{B}$

Where G = dry gas wt. $= C \times \dfrac{11CO_2 + 8O_2 + 7\,(CO + N_2)}{3\,(CO_2 + CO)}$

3. Heat loss in unburned gas, per cent $= \dfrac{\dfrac{CO}{CO_2 + CO} \times 10{,}160 \times C \times 100}{B}$

4. Heat loss due to moisture in fuel, per cent $= \dfrac{M\,(1089 - t_f + 0.46\,T) \times 100}{B}$

5. Heat loss due to water from combustion of hydrogen,

$$\text{per cent} = \frac{9 \times H \times (1089 - t + 0.46\,T) \times 100}{B}$$

6. Heat loss due to combustible in refuse (for coal-fired installations only),

$$\text{per cent} = \frac{R \times K \times 14{,}600 \times 100}{B}$$

7. Radiation and Unaccounted for loss $= 100 - [\,(1) + (2) + (3) + (4) + (5) + (6)\,]$

The excess air loss is included in the above losses. Frequently it is desirable to approximate the loss due to excess air alone, in which case the following formula applies: Heat loss in excess air, per cent $= 0.019E\,(T - t)$

Where E = Excess Air $= \dfrac{O_2}{0.264N_2 - O_2}$, expressed as a decimal fraction

The symbols used in the foregoing formulas are:

- W = Lb. of steam evaporated per hour.
- F = Lb. of fuel burned per hour.
- B = Btu. per lb. of fuel as fired.
- H_s = Heat in steam at outlet of unit, Btu. per lb.
- h_F = Heat in feed water entering unit, Btu. per lb.
- T = Temperature of gas leaving unit, F.
- t = Temperature of air entering unit, F.
- t_f = Temperature of fuel entering unit, F.
- C = Lb. of carbon burned per lb. of fuel as fired, calculated from the ultimate analysis of fuel.
- M = Lb. of moisture per lb. of fuel as fired, from the ultimate analysis of fuel.
- H = Hydrogen per lb. of fuel as fired, from the ultimate analysis of fuel.
- R = Refuse per lb. of fuel as fired.
- K = Combustible per lb. of dry refuse.

CO_2, O_2, CO, and N_2 are percentages by volume of the several gases, secured from the gas analysis.

Throtting Calorimeter Formula:

$$\text{Moisture in Steam, per cent} = \frac{H - 1150.4 - 0.47\,(t - 212)\,100}{L}$$

Where H = Total heat in steam at boiler pressure
L = Latent heat in steam at boiler pressure
t = Temperature of steam after passing orifice during test.

Here is a form for calculating the heat balance of a boiler that should be of value to all operating engineers. It is reproduced here from Babcock & Wilcox Company's bulletin on Marine Boilers but, of course, the method is equally applicable to any stationary type of boiler.

CARBON THAT WIPES AWAY

SUN DIESEL LUBRICANTS . . .

stop ring sticking . . . cut operating costs

Heavy carbon . . . gummy deposits . . . stuck rings in a diesel do not add up to efficient operation. And this trouble may often be traced directly to the lubricant.

Breaking rings to free them during the annual overhaul of a six cylinder diesel was the general practice of a large New England contractor. The lubricants he was using formed hard carbon and power-killing gummy deposits. Parts replacement costs ran high and overhauling became an expensive proposition.

Costs dropped after a Sun Oil Engineer suggested a change to a Sun Diesel Lubricant. No excessive carbon deposits were present at the next overhaul. The slight amount that did form was of a soft nature which was easily wiped away. All piston rings were free, including the top rings. Costs of lubrication and replacement parts dropped to a new low.

Engineering "Know How" of Sun Engineers and the proved quality of Sun Lubricants can do much to step up the operating efficiency of your diesels, gas engines, gasoline engines, steam turbines or electric motors. Sun service is yours to use for improved production, lower costs and more efficient operation. Write . . .

SUN OIL COMPANY • ***Philadelphia 3, Pa.***

Sponsors of the Sunoco News Voice of the Air — Lowell Thomas

SUNOCO

SUN INDUSTRIAL PRODUCTS

OILS FOR AMERICAN INDUSTRY

Store Coal—NOW

(Continued from page 85)

consumers having more than five days' supply on hand but permitting delivery of one ton or enough to last seven days to consumers having less than five days' supply on hand.

It was announced on January 31 that SFAW had begun wide-scale diversions of bituminous coal in transit to supply hard-pressed retail dealers in New York, Pennsylvania and Ohio. Coal was being diverted, as far as possible, from industries with stockpiles sufficient for immediate use.

Announcement was made on March 9 that household consumers of all solid fuels east of the Mississippi River and in certain other areas would be required to file "consumer declarations" with their retail dealers to receive the 80 per cent of normal allotments to which delivery will be restricted in the fuel year beginning April 1, 1945.

The above briefed directives are only a few of the many that were issued by the Government, they are, however, typical and no doubt they were highly instrumental in preventing hardship for many fuel users during the past winter. These were not mere suggestions and requests, for many of them carried with them the force of law and disciplinary measures of enforcement were necessary in some cases of violation, although those reported have been remarkably few considering the extent of the restrictions imposed. Most of these directives were temporary, being designed to meet emergency conditions and are now being liberalized, particularly since the fall of Germany. The problem confronting fuel users now is to make such drastic measures unnecessary during the coming winter.

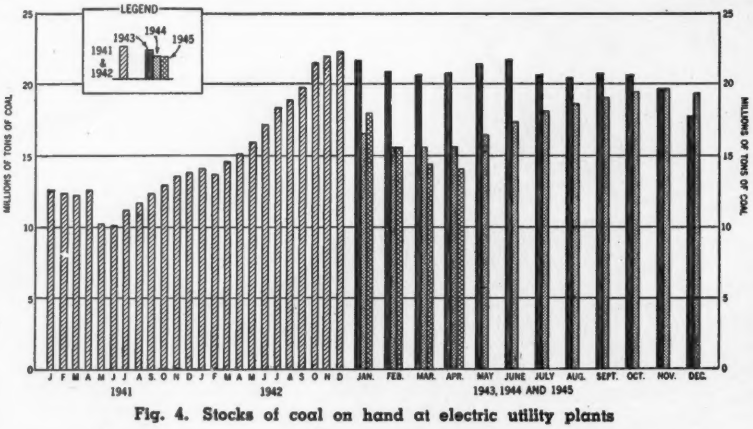

LEGEND
1941 & 1942
1943
1944
1945
MILLIONS OF TONS OF COAL
J F M A M J J A S O N D J F M A M J J A S O N D
1941
1942
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1943, 1944 AND 1945

Fig. 4. Stocks of coal on hand at electric utility plants

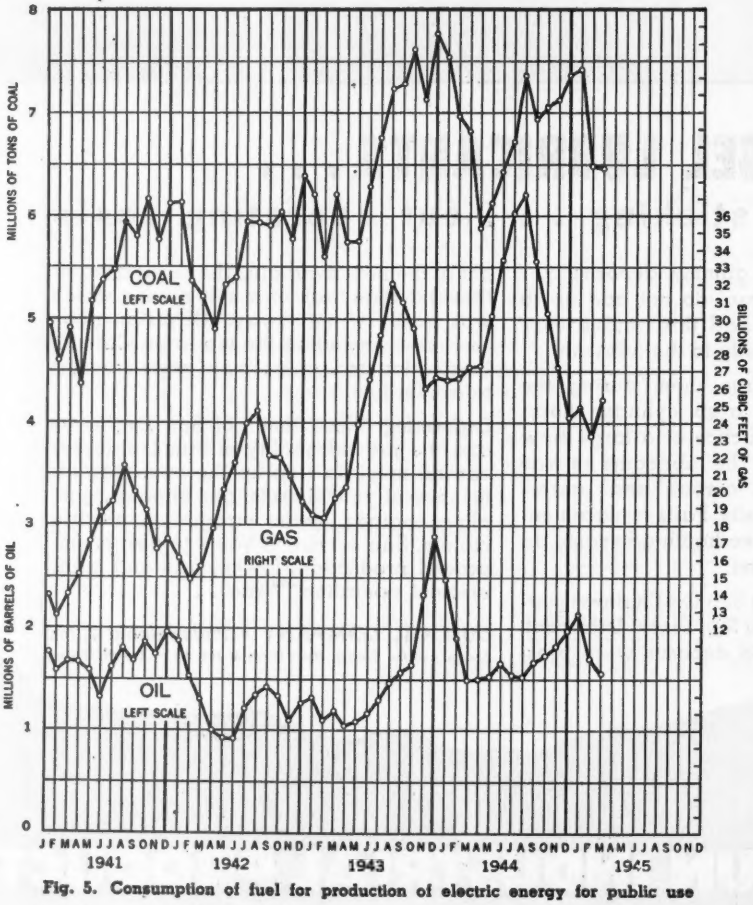

MILLIONS OF TONS OF COAL
MILLIONS OF BARRELS OF OIL
BILLIONS OF CUBIC FEET OF GAS
COAL
LEFT SCALE
GAS
RIGHT SCALE
OIL
LEFT SCALE
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1941
1942
1943
1944
1945

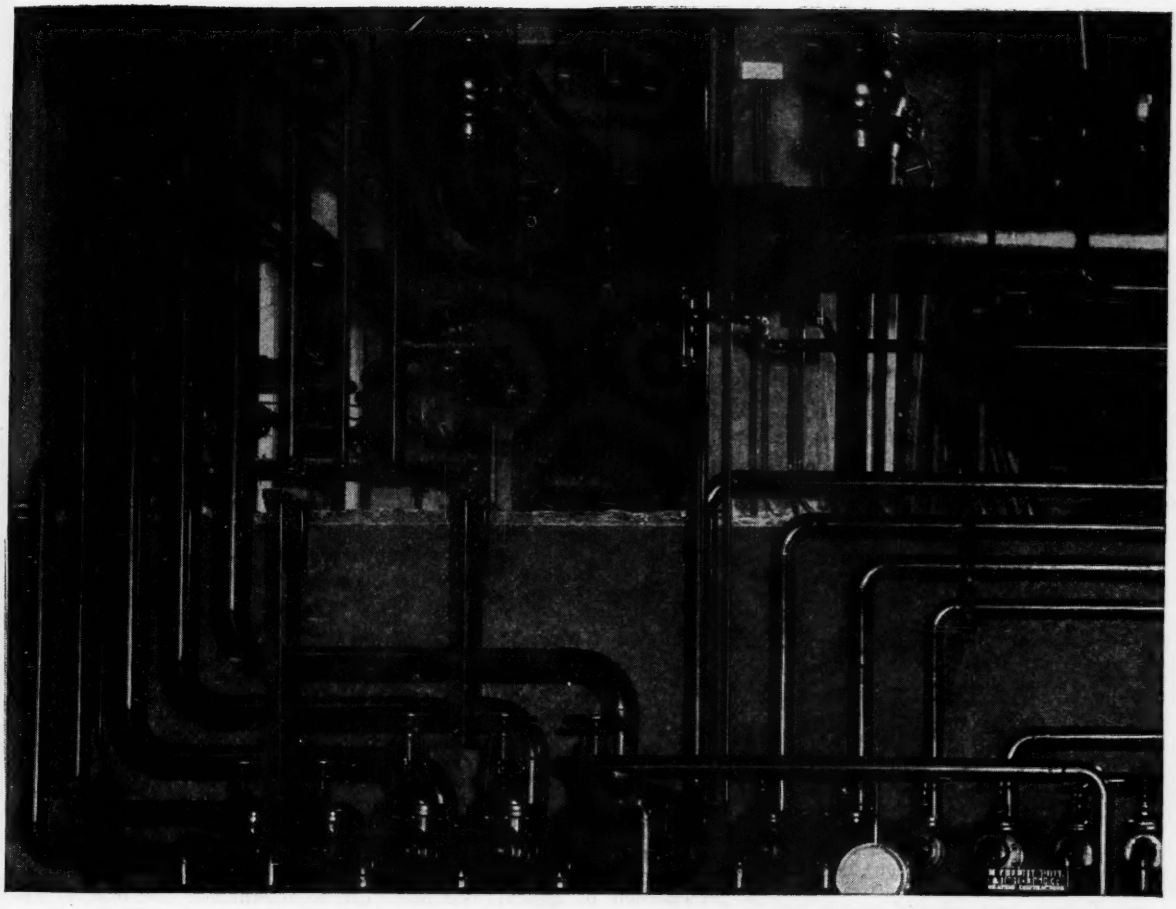
Fig. 5. Consumption of fuel for production of electric energy for public use

Fuel Economy

Taking a long range view of the fuel supply problem, the engineer invariably thinks in terms of efficiency, getting the greatest possible output from a given input, using the least amount of fuel or heat units to accomplish the ultimate purpose. With this in mind the Bureau of Mines sponsored the organization of a committee of nationally known engineers specialized in the use of fuels which formulated the National Fuel Efficiency Program. The entire country was organized for a block-by-block campaign to assist fuel users in obtaining higher efficiency from their fuel. This Program has been effective not only in securing higher combustion efficiency but also in chasing down wastes in the application of the services resulting from the combustion of fuel. The service performed by this committee will be beneficial to the country for years to come, for the information gathered and instructions given have been put into printed form and will be of permanent value to all interested persons.

Reports indicate that savings ranging from 3 to 35 per cent in fuel consumption are traceable directly to the work of this voluntary organization of workers which has set as its annual goal the saving of 29,000,000 tons of coal and proportional amounts of oil, gas and other fuels. The technical facilities of the Bureau of Mines has thus been made available to all industries and commercial consumers through the voluntary organization of about 10,000 combustion engineers, co-ordinators, and "waste chasers" throughout the country.

The savings reported have been made almost entirely by employment of more efficient methods of operating the equipment in service at the time the program was initiated. While "waste chasers" found numerous cases where the equipment in service was definitely obsolete, war restrictions prevented modernization, a condition which has greatly handicapped the fuel saving program. With the war in Germany at an end, it is hoped that installation of modern highly efficient equipment will be permitted to a greater extent than it has been, thus giving fuel users the means by



The fittings that snuggle up

IT makes a lot of difference, when you're laying out a piping system, whether you use Tube-Turn welding fittings that snuggle up to each other going around corners—or other type fittings that demand a world of "elbow room." Lines can be placed nearer to ceilings and walls and nested closer in smaller tunnels.

Other important advantages of Tube-Turn welding fittings include lighter weight, greater strength, and longer life. Their streamlined design permits easier insulation, and the fact that they are permanently leakproof means that insulation will not have to be replaced. Smooth turns insure maximum efficiency of flow.

Specify Tube-Turn welding fittings for your next piping job, and gain all these money-saving benefits!

For complete information on the superiority of Tube Turns' exclusive manufacturing methods and data on successful installations in many industries, write for Catalog 111.

• • •

Selected Tube Turns Distributors in every principal city are ready to serve you from complete stocks.

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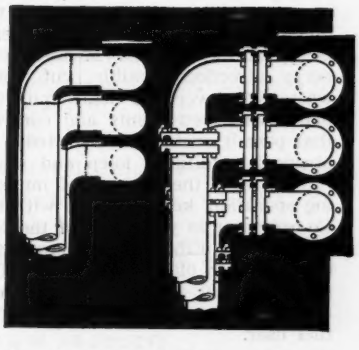


See how much less space is required for compound turns made with Tube-Turn elbows!

TUBE-TURN TRADE MARK *Welding Fittings and Flanges*

which modern efficiencies can be obtained.

Store Coal

Unless conditions change greatly, and no doubt some relief will be had from manpower shortage and transportation difficulties, the fuel problems of next winter will be no easier of solution than they were last winter, except perhaps that the pattern for their solution has been set and can, with some variations, be followed under similar fuel-shortage conditions.

Fuel users will probably not be permitted to store sufficient coal during the summer months to last them through to April 1, 1946, but they will do well to store all that the Government will permit and to make those arrangements now. At the time of this writing consumption is greater than production with industries digging into their reserve stocks to supply their needs. This condition, however, will no doubt change soon and consumers should have their orders in early so as to get their stock piles built up for whatever contingencies may arise. These orders will act as a stimulant to encourage full production of mining and transportation facilities.

SFAW has revoked a number of winter emergency coal restrictions in order to encourage spring and summer rebuilding of stocks. One of these new orders require dealers to deliver 30 per cent of their annual requirements by October 1 to domestic consumers who complied with certain regulations, and permits dealers to deliver up to a maximum of 50 per cent of the consumer's annual requirements before September 1.

At this time, engineers in power plants can do most toward easing the fuel situation by building up the efficiency of their plants. Modernize in every direction possible, cut down wastes of power and heat, equip the plant with instruments and controls that permit continuous knowledge of physical conditions, keep and study records with the purpose of improving operation, keep in touch with the Co-ordinator in your area of the National Fuel Efficiency Program for suggestion on plant betterments. The need for fuel saving is urgent and requires the co-operation of every fuel user.

Centrifugal Pump Control

(Continued from page 83)

pressures or even to water hammer under certain operating conditions. It is usual in such cases to provide protection both for the pumps and for the system in some form, such as air chambers, surge tanks on relief valves. The exact nature of the protective controls is highly dependent upon all the features of the system into which they are incorporated and must be solved individually.

As a result, it would be highly misleading to indicate any overall rules or suggestions on the application of such controls. However, relief valves may be used to protect certain separate portions of the system against pressures which may be suitable for the remainder of the system but excessive to that portion. One typical example of this application is the use of relief valves in the suction line of a pumping system provided with both check valve in the discharge and footvalve in the suction. The latter is seldom suitable for the pressure which may exist in the discharge piping and may need protection against the possible failure or leakage past the discharge check valve.

The surge suppressor used in some discharge lines is a reverse form of relief valve or rather a relief valve which opens sufficiently in advance of the occurrence of excessive pressures to afford full protection against water hammer. This valve is arranged to open on an excessive *drop* in discharge pressure and close *very slowly* as the pressure is again built up. When the check valve in a discharge line closes suddenly, the excessive pressures caused by water hammer are preceded by a sudden drop in pressure immediately beyond the check valve. By the time the surge or rise in pressure takes place, the surge suppressor valve is fully open and ready to relieve the situation.

The foregoing is intended mainly as a presentation of typical examples rather than a listing of all the possible control solutions which may act to protect either the pump, its driver or the system in which the pump is operated.

Armature Winding Diagram

(Continued from page 93)

phase-line are connected together. (b)..Assume one position to be 0° as before, and the other two positions to be 60° and 300°, then the *delta* connection would be 0°-60° for A, 300°-240° for B, and the remaining two leads are joined together for phase C.

(4)..In the form of a slot-star for Figs. 1a, 2 and 2a, sketch the order of vectors and the magnetic field angles which occur between phase slots or repeated groups, etc.

Ans. Fig. 5A shows the slot-star of winding Fig. 1a which has an integral number of slots and coils per pole per phase; Fig. 5B shows the slot-star of winding Fig. 2 which has a fractional number of slots per pole per phase; and Fig. 5c shows the slot-star of winding Fig. 2a which has an integral number of slots and fractional number of coils per pole per phase.

(5)..Assuming voltage E per phase of a 3-phase stator 2-pole machine, show by vector angles (a)..Incorrect *delta* connection with reversed phase winding; (b)..Incorrect *star* connection with reversed phase winding. (Mark direction of current in each phase winding.)

Ans. See sketch D; check with Fig. 1 and answers to Questions (2) and (3).

(6)..What class of *lap* winding can be used in a 2-pole (one unit) machine? (b) Can a *wave* winding be used in a 2-pole (one unit) machine?

Ans. That "unit" class in which adjacent phase-groups are connected in series, sometimes called "identical pole-pair" lap winding.

(b)..No. Coil group connections are of like polarity and therefore require a minimum of 4-poles or 2-pole pairs.

(7)..For an integral slot winding explain how Fig. 1 shows that each magnetic pole represents a repeated group; (b)..for a fractional slot winding explain how Fig. 2 shows that each pole-pair represents a repeatable group.

Ans. With an integral number of slots per pole per phase the vectors 1, 2, 3 are shifted 180° with respect to 4, 5, 6, hence, as shown in Sketch A, 1-4 is 0°, 2-5 is 60° and 3-6 is 120° so that one pole makes a unit.

(b)..With a fractional number of slots per pole per phase no vector is shifted 180° with respect to another vector and it is seen from Fig. 2 that slot 6 (vector 6) lies between slots 1 and 2 (vectors 1 and 2); the same conditions occur in phases B and C, hence two poles make a unit.

Combustion Calculations

(Continued from page 96)

it is not necessary to distribute the carbon. When 100 mols of dry products are used the mols will be equal to the orsat analysis. The mols of carbon will be the mols of C in the CO (0.10) plus the mols of C in the CO_2 (14.3) giving a total of 14.4 mols or 173 lb. Since the weight of C in the fuel must be 173 lb, this establishes a ratio between per cent by weight and 173. 173 lb = 26.78 per cent. 1 per cent = 173 ÷ 76.78. The sulfur in the fuel will be 1.18 x 173 ÷ 76.78 = 2.7, etc. Once the weight of the elements in the fuel have been calculated the number of mols of each can be calculated. This will determine the H_2, O_2, N_2 and S in the fuel. Once the mols of SO_2 and H_2O have been determined the O_2 in the fuel can be determined. The oxygen supplied in the air will be 22.16 mols — 0.5 mols in the fuel or 21.66 mols.

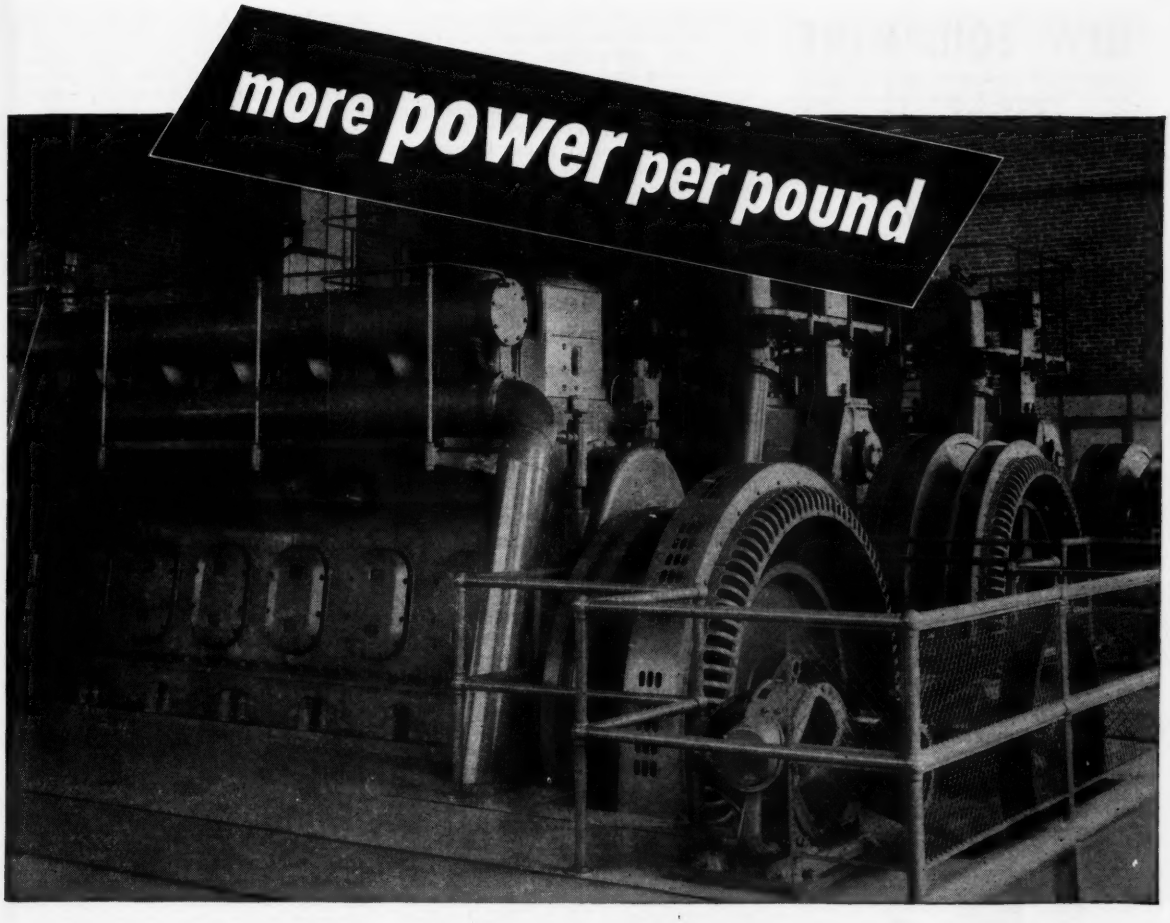
Table VIII shows the same calculations when the calculation is made on the basis of 100 lb of fuel. In this case the mols of carbon in the fuel can be immediately determined. The mols of carbon in the flue gas or products is distributed between the CO and CO_2. Since each gas requires one mol of carbon per mol of gas, the carbon will be distributed between them on the basis of their percentage by volume.

$$\text{Mols of C in CO} = \frac{0.1}{14.3 + 0.1} \times 6.56 = .045$$

$$\text{Mols of C in } CO_2 = \frac{14.3}{14.3 + 0.1} \times 6.56 = 6.515$$

Since the mols of C in CO_2 equal the mols of CO_2, we know that 14.3 per cent = 6.515 mols. 1 per cent = 6.515 ÷ 14.3. The mols of the remaining dry gases can be found by multiplying their per cent by this factor.

STUDIES IN THE General Electric Laboratories have developed the use of X-rays for determining unknown chemical substances in materials under investigation. This method of identifying elements is said to be very rapid and is applicable to gases, liquids or solids.



ONE of the important achievements of Baldwin engineering

The picture tells the story of one important Baldwin development. The Baldwin Diesel in the foreground generates almost as much power single-handed as the *two* larger diesels in the background: 500 kw. as against a combined output of 540 kw

The Baldwin VM Diesel incorporates every successful advance in 4-cycle diesel design, while providing an economical, compact, highly efficient unit that requires a less expensive generator than low-speed engines, demands a smaller foundation, and can be housed in a smaller engine-room. It offers real profit possibilities to plants requiring dependable, low-cost power in a 500-1000 hp package. The special injection-combustion system makes the engine less sensitive to variation in fuel oils. All moving parts are enclosed, but are easily accessible.

The comprehensive line of Baldwin Diesels includes a type to fit each need. Talk to a Baldwin representative before you buy. The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston, Pittsburgh, Detroit.

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Hydraulic presses, Testing equipment, Steel forgings and castings, Diesel-electric locomotives, Diesel engines, Metal plate fabrication, Rolled steel rings, Bronze castings, Heavy machine work, Crane wheels, Bending rolls, Plate planers, Babbitt metal, Alloy iron castings, Briquetting presses.

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BALDWIN

DIESEL ENGINES

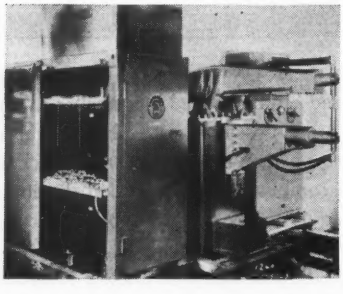
NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. Write to POWER PLANT ENGINEERING 53 W. Jackson Blvd., Chicago 4, Ill.

Storage Battery Welder

ANNOUNCEMENT COMES FROM the Progressive Welder Co., Detroit, Mich., of the development of a storage battery powered resistance welder. Such welders do not throw continually varying loads on the line. They are maintained at charge by simple automatic battery chargers operating from ordinary factory power lines. This type of load represents low demand at high power factor and an interference-free wave shape. It thus promises to eliminate many problems that have heretofore handicapped central station operations.

The storage battery welders apparently reduce peak welder loads as much as 90 per cent for typical welding operations. This permits welding to be done in localities where high power line capacity is not available and releases manufacturers' and utilities' plant capacity for other purposes. It makes unnecessary the reserving of capacity in generation and distribution plants to accommodate the high momentary demands imposed by conventional resistence welding equipment.



The principle of welding with storage battery power is not new but its application has been limited by the practical difficulty encountered in breaking the enoromous currents required for welding the materials used in industrial fabrication. With the development of a contractor-controller by the Progressive Welder Co., capable of the arcless interruption of currents up to 30,000 amperes or more storage battery welding was made possible. A modified form of the familiar carbon pile rheostat, the contractor-controller utilizes the property of certain carbon compounds to provide high electrical conductivity when subjected to mechanical pressure and to rapidly decrease their conductivity as the pressure is released. Proper selection of the area and thickness of carbon discs, rate of application and release of pressure and the time of contact permits complete control of battery current for any welding operation within the capacity of the batteries provided.

The range of storage battery welders now available includes spot, roll-spot, and projection in both the rocker arm and pedestal types. Design is such that the battery is an integral part of the machine for small and medium power capacity and separate power packs house the batteries for higher power requirements. Models for 6, 12, 16 and 30 cells have been standardized, the 6, 12 and 16 cell models being integral with the welder.

Portable Diesel Power Plant

PRODUCTION OF A NEW type Diesel generating plant is announced by Bardco Manufacturing & Sales Co., Los Angeles, Calif. The plant delivers 37.5 kva 60 cycle current at 240 v, 3 phase, and at 120 and 138 v, single phase.

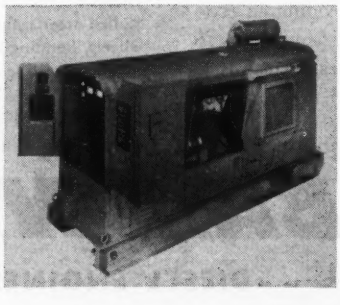
Mounted on a welded I-beam frame, the 5000 lb plant may be hauled or skidded to any desired location. Completely contained in a heavy-duty, sheet-metal housing, it may be operated under any weather conditions, and in any climate. Louvres on both sides of the housing are adjustable for warm or cold climates.

The alternator, is a single-bearing flange mounted type, and is connected to the Diesel engine by a special flexible coupling. The exciter is built-in and of a new type that greatly reduces the over-all length of the alternator. Cooling of the alternator is by forced draft, with four air filters on the inlets, and a thermostat on the exhaust air which operates an alarm should the alternator become overheated.

The engine is a 6-cylinder Chrysler industrial engine, Model IND-3, which has been modified for its use in the Bardco generating plant. The engine operates at 1800 rpm, and delivers 61 net brake horsepower, at that speed.

Operation of the entire power plant and its engine is controlled from a single instrument panel. A reed-type Frahm frequency meter is used to adjust the engine speed for 60 cycle operation and is connected across one phase of the alternator. When two or more of these plants are to be operated in parallel, synchronizing lamps on the instrument panel are used to bring the two plants into step. A voltage regulator maintains the voltage output of the alternator and is equipped with a special strip-type heater for operation in extremely cold climates.

Cooling of the Bardco plant is by radiator and fan, mounted at the opposite end of the assembly from the control panel. A 24-v electric starting system is provided, with batteries located within the engine compartment. Provision is also made for plugging-in an external source of starting battery power should the regular test of batteries be too low to start the Diesel.



All-Position Welding with A-C

WESTINGHOUSE ELECTRIC CORP., East Pittsburgh, Pa., has announced the development of an a-c electrode, known as the ACP, which meets the requirements of the standards for welding set by various associations. The new electrode includes an arc pacifier that prevents excessive spatter loss during the negative half cycles and an arc stabilizer to aid in reestablishing the arc after each current zero.

For best performance on vertical and overhead arc welding, a high organic electrode coating is used. This coating provides an envelope of burning gas that keeps the oxygen and nitrogen in the atmosphere from contaminating the weld metal. This type of coating leaves but a scanty slag over the deposited metal that does not interfere with welding. This high-organic coating has the quality of working in a satisfactory manner when the current flows in one direction but not the other. Obviously, d-c welding is easily performed in these positions but alternate half-cycles of a-c welding would be unsatisfactory. This restriction has impeded the progress of the much simpler a-c welding for some fifteen years.

Haze Indicator for Diesel Exhaust

HAZEGAGE IS AN INSTRUMENT developed by The Ess Instrument Co. of Ft. Lee, New Jersey, to evaluate the exhaust haze from Diesel engines and constantly monitor fuel-air ratio in order to maintain the quality of haze indicative of optimum engine efficiency. Another factor of major import is that smoky exhaust indicates danger from sludge forming in the lubricating oil.

A Hazegage consists of three parts; a light unit, a photo-electric unit and an indicator which has a scale and two different colored lamps (red and green). In operation the light unit, equipped with a standard electric bulb, shoots a ray of light through the exhaust haze; the photo-electric unit measures the density of

PROOF that Edward streamlined flow cuts pressure loss, saves money

Here's evidence that pressure loss through your small globe valves can be greatly reduced, or that greater volume of flow can be had with the same pressure loss, by standardizing on Edward 60° stem forged steel globe valves.

See the result of Edward Valve streamlining in less turbulence, higher efficiency and maximum volume at the equipment where it's needed.

$$h = \frac{1}{K^2} \frac{w^2}{1891^2 D^4 \rho}$$

THIS formula for computing pressure drop is based on material presented in *Fluid Meters—Their Theory and Application.** Provided the value of K is known, pressure drop through any valve can be calculated accurately. K is a factor dependent upon the general shape and contour of the valve and is determined by experimentally measuring flow and pressure drop through the valve. If resistance to flow is low, K approximates 1; with high resistance to flow, K approaches 0. Values for K, shown below, for Edward Fig. 2688 type valve and typical ordinary forged steel globe valve were determined through experiments on Edward flow test lines.

*American Society of Mechanical Engineers, 1937.

h—pressure drop through valve, psi.

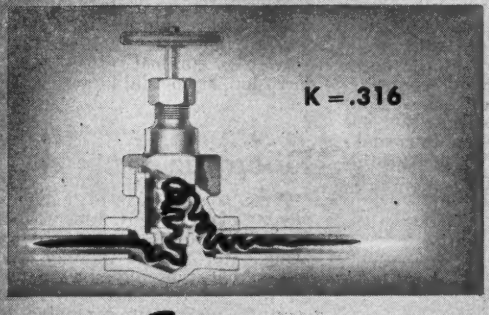
K—valve (or flow) coefficient.

w—weight of fluid through valve, lb/hr.

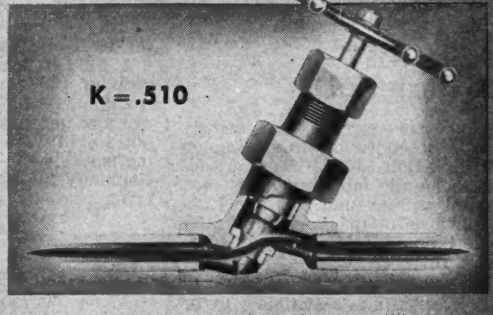
D—nominal pipe size.

ρ—density of flowing fluid, lb/cu. ft.

"X" VALVE



EDWARD 60° Stem VALVE



Steam . . . 10,000 lb/hr, 740 F, 525 psi, 2" line

$$h = \frac{1}{.316^2} \frac{10{,}000^2}{1891^2 \times 2^4 \times .797} =$$

h (pressure drop, psi) = 21.9

$$h = \frac{1}{.510^2} \frac{10{,}000^2}{1891^2 \times 2^4 \times .797} =$$

h (pressure drop, psi) = 8.44

Water . . . 50,000 lb/hr, 300 F, 900 psi, 2" line

$$h = \frac{1}{.316^2} \frac{50{,}000^2}{1891^2 \times 2^4 \times 57.4} =$$

h (pressure drop, psi) = 7.65

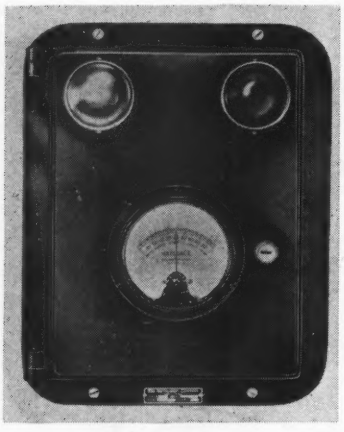
$$h = \frac{1}{.510^2} \frac{50{,}000^2}{1891^2 \times 2^4 \times 57.4} =$$

h (pressure drop, psi) = 2.94

Sharp turns in flow cause excessive turbulence (which promotes valve wear) and increase pressure drop (which wastes power). Edward 60° stem valves ease flow through with no sudden changes in direction.

EDWARD *Steel* VALVES

The Edward Valve & Manufacturing Co., Inc. • East Chicago, Indiana



the haze in the path of light and shows it on the scale of the indicator. Whenever combustion varies so that the haze is either too thick or too thin, the lamps will light; green for too thin a haze and red for too thick a haze. The pointer on the scale, being set to zero to show optimum haze, will move to the left for too thin or to the right for too thick a haze. As the fuel-air ratio is corrected the lamps will go out and the pointer will go back to zero on the scale, indicating optimum engine efficiency.

If desired, sound alarms can be supplied with each Hazegage or if records are required, recorder equipped instruments are available to keep a 24 hr record of the performance of one or a battery of Diesels.

Conveyor for Bulk Material

THE DEVELOPMENT of an entirely new type of conveyor, to be known as the Link-Belt Sidekar-Karrier, designed to handle bulk materials in a horizontal run-around path, within minimum headroom, is announced by Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

The new Karrier provides conveyor storage for materials that are to be discharged simultaneously in varying quantities at a number of points.

Any surplus material that is still left in the conveyor buckets after they have served the several discharge points, will remain in the buckets, to be recirculated.

The conveyor is both self-feeding from any one of many feed spouts which may be located above its horizontal run-around path of travel, and self-discharging to any number of points, thus permitting continuous automatic operation.

Another feature that characterizes the Sidekar-Karrier is the fact that the material is carried in buckets supported on rollers. The design is such that two or more materials can be separately fed to the conveyor with the assurance that the admixture will not be disturbed in transit, and that it will be delivered to any predetermined discharge point in exactly the same mixed proportions as prevailed at the feed points.

The Link-Belt Sidekar-Karrier is available in two types. Type 1 is recommended for boilerhouse applications, where coal is kept in bunker storage and delivered to one or more scale hoppers, as in cases where each boiler is fitted with individual weigh scales.

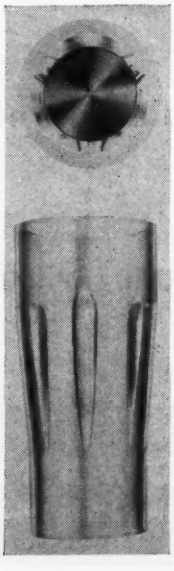
Type 2 Karrier has been designed and installed to handle capacities of up to 100 tons per hour, particularly where it is important that the material does not suffer either from degradation or segregation.

Both Type 1 and Type 2 Sidekar-Karriers are adapted to the efficient handling of other bulk materials besides coal. Handling magnesium pellets without degradation, for example, is being done with the Sidekar-Karrier.

Rotameter Tube

FISCHER & PORTER CO., 959 County Line Road, Hatboro, Pa., announces a new Rotameter tube made of borosilicate glass that greatly simplifies rotameter construction. It is called the "Bead-Guide Tube" and has three straight glass ribs running up the inside of the tube to guide the rotameter float throughout its travel. There is only a hair line contact between the float and each raised rib.

A guided float improves the accuracy of the rotameter by centering the float, it also prevents tube breakage and permits float shapes that are not stable without guides, thus making possible the Stabl-Vis float of this Company for measuring fluids of varying viscosity with high accuracy.

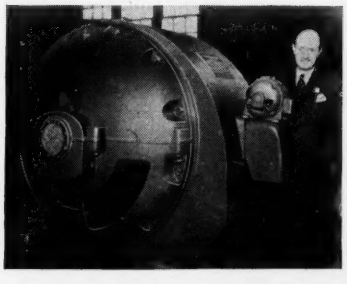


The Bead-Guide Tube eliminates the center guide wire previously used to stabilize to float and solves the corrosion problem. The three ribs running up the rotameter tube also gives it greatly increased strength. This new tube can be readily adapted to existing rotameters.

New 2000-Hp Tri-Clad Motor

GENERAL ELECTRIC CO., Schenectady, N. Y., has announced a new 2000-hp Tri-Clad motor, the largest to be added to this line, which is a squirrel-cage induction-type motor, and is specially designed for use in large central power stations and large industrial applications.

The new motor is five steps larger in diameter than the largest standardized frame. It operates at 1800 rpm, is rated 2000-hp, 2300-v, 3-phase, 60 cycles.



All of the basic protective features of the Tri-Clad line are incorporated. These include protection against physical damage, electrical breakdown, and operating wear and tear. The end shields are of split cast-iron construction to facilitate maintenance and provide exceptional resistance to rust, corrosion, accidental blows, and rough use.

Fiberglas Mat

THIN, POROUS MATS of bonded glass fibers, made by Owens Fiberglas Corp., Toledo, O., and originally developed for use as retainer mats in storage batteries and widely employed for this purpose, have now been successfully applied to a number of entirely new uses in the electrical and process industries fields.

Primarily because of the high tensile strength and non-hygroscopic characteristics of the industrial glass fibers, the Fiberglas mats are being employed as the base for a new plastic laminated material. Possessing a low and stable loss factor over a wide frequency range, the laminate greatly extends the field for plastic coil forms, condenser spacers, stand-off insulators, etc., in radio, television and other high-frequency electronic devices.

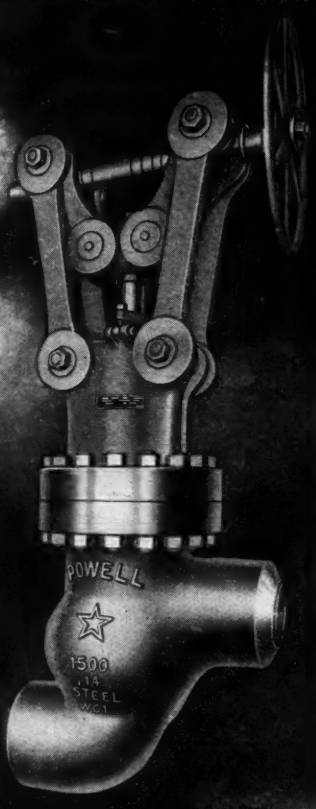
In building up the laminate, the Fiberglas mats are impregnated with a thermo-setting aniline-formaldehyde resin, and are cured under high pressure. In addition to its low loss factor, the laminate possesses high strength, high temperature resistance, dimensional stability and resistance

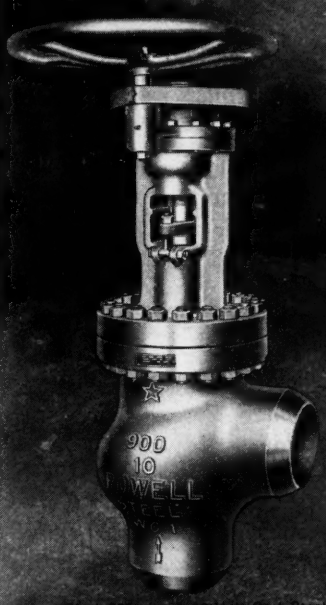
(Continued on page 138)

Powell Valves
comin' through

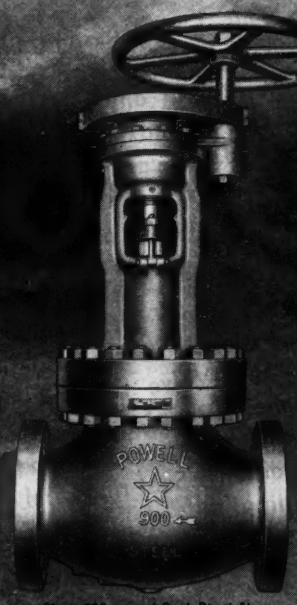
Every day thousands of valves of all types, designs and materials are "comin' through" the various stages that make the name "Powell" on a valve the hallmark of quality. Into every step—from perfect casting to final merciless testing—goes the KNOW-HOW of 99 years of concentration on making valves—and valves only—for industry.

When they are finally pronounced worthy in every detail to bear the Powell name, they go out to join the hundreds of thousands of their family who are "comin' through" with flying colors under all kinds of service conditions in every branch of American industry.





Class 900-pound Cast Steel Non-return Angle Valve with welding ends. Spur gear operated.



Class 900-pound Cast Steel Non-return Globe Valve with flanged ends. Spur gear operated.

Powell Non-return Globe and Angle Valves are scientifically designed and engineered, with streamline bodies that provide maximum flow area with minimum pressure drop. They can be supplied in various sizes for all pressure classes from 300 pounds to 2500 pounds, inclusive.

The Wm. Powell Co.

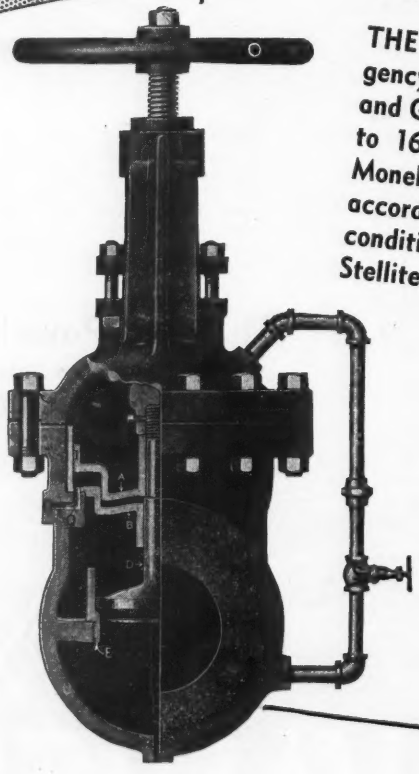
Dependable Valves Since 1846

Cincinnati 22, Ohio

POWELL VALVES

Here's an "Automatic Brake" for Runaway Turbines

This Throttle and Emergency Stop Valve acts instantly and automatically to prevent any turbine unit from exceeding maximum safe operating speed. It can be invaluable to you because it permits location of trouble before damage occurs.



THE GOLDEN-ANDERSON Emergency Stop Valve is supplied in Angle and Globe patterns, in sizes from 2½" to 16". Valve trim may be Bronze, Monel, Stainless Steel or Gallavoy according to pressure and temperature conditions. Seat rings and disc may be Stellited.

Write today for your copy of the latest G-A Catalog. It illustrates and describes the complete line of G-A Valves.

GOLDEN-ANDERSON
VALVE SPECIALTY CO.
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Look FURTHER into PREHEAT ENGINEERING

THE *Ljungstrom* AIR PREHEATER

The Ljungstrom operates on the continuous, regenerative, counterflow principle. As hot gases pass through the heating section of the unit, metal elements of the rotor soak up the heat then rotate into another section, sealed from the first, where this heat is transferred to the air or gas to be heated.

In addition to its contribution to higher heat recovery in steam generation, the Ljungstrom Air Preheater has other important industrial applications. If your process requires, or can use to advantage, preheated air or gas up to 1,400 deg. F., it will pay you to investigate the possibilities of the Ljungstrom.

Today, preheat engineering is improving copper smelting, aiding operation of waste disposal plants, lowering the cost of production of synthetic rubber. Chemical and metallurgical industries are exploring its potentialities as applied to all their processes employing heated air or other heated gases. Dehydrating plants, too, are looking further into its possibilities.

ENGINEERING SERVICE

The engineering staff of The Air Preheater Corporation is prepared to assist you in applying standard or special types of Ljungstrom preheaters to combustion improvement or to other, newer, uses. So that you may benefit from designing the Ljungstrom into your plant or process, call in the preheat engineer while plans are still in the formative stage.

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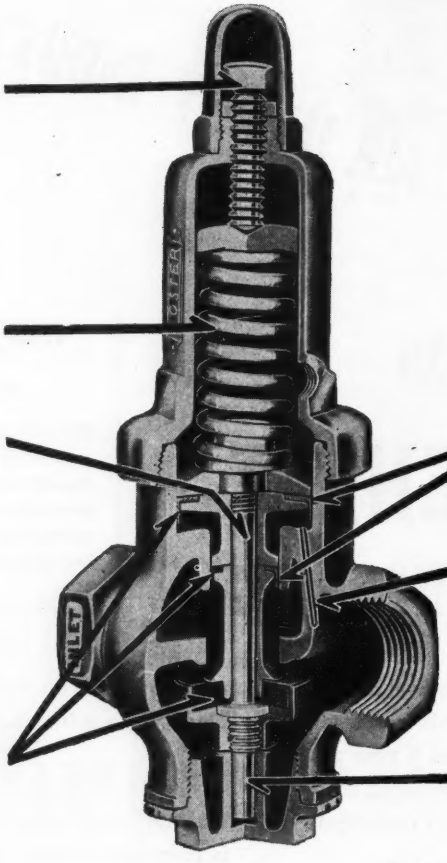

1 Easily set under pressure

2 Springs "flexible" cadmium plated

3 Stems, special high-tensile bronze to minimize stretch from pressure shock

4 Soft disc and leather sealing cups renewable

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Foster Type U, Spring-loaded Direct-acting Reducing Valve for Water and Air Service

Foster Regulation Engineering, built into each valve, is your assurance of years of accurate, trouble free operation

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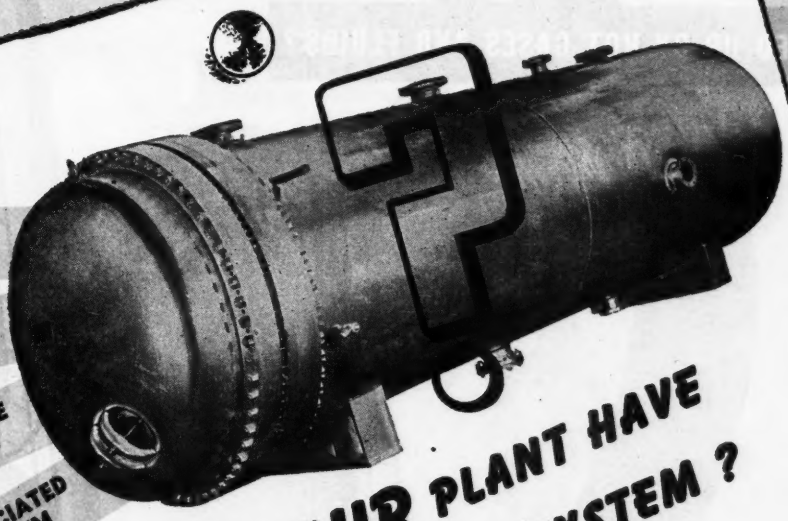

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SINGLE EFFECT

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SHOULD YOUR PLANT HAVE AN EVAPORATOR SYSTEM ?

ONE OF A SERIES OF ADVERTISEMENTS DESCRIBING THE MANY TYPES OF G-R HEAT TRANSFER APPARATUS

The fact that one or more of your neighboring plants do or do not have an evaporator system for distilling their boiler feed make-up may not be a safe guide for you to follow—even if these plants seem to be similar to your own.

Operating conditions, steam demands, quality of raw water supply and plant heat balance—all are factors in determining the advisability of an evaporator installation. These factors are distinctive in each plant and require individual study. Griscom-Russell brings to such a study the accumulated experience of 77 years of pioneering in the development and application of evaporator systems, and the results obtained in many hundreds of evaporator installations.

These are some of the reasons why Griscom-Russell recommendations are authoritative, and why you can depend upon their advice as to the advisability of an evaporator system for your particular plant conditions. Write for complete information, without obligation.

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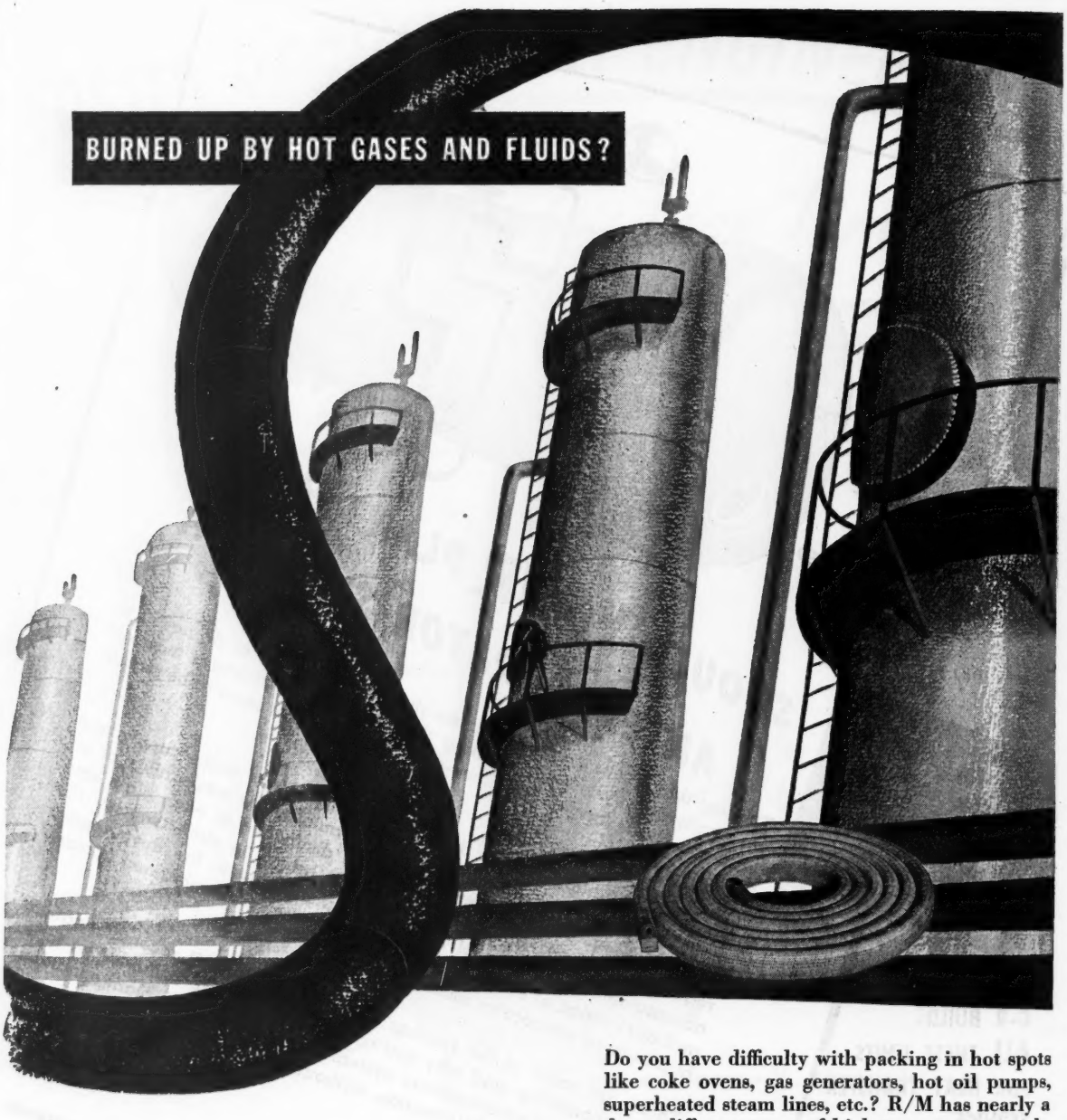
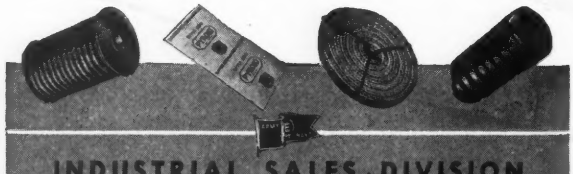


Do you have difficulty with packing in hot spots like coke ovens, gas generators, hot oil pumps, superheated steam lines, etc.? R/M has nearly a dozen different types of high temperature packings, recommended for services up to 1200° F.

Fabricated of asbestos and other heat-resisting materials, these packings have never been surpassed in their ability to work when the heat's on. Probably one of these special packings can help you keep cool, when operating temperatures are high.

More than forty years of experience, coupled with continuing research into all branches of the packing field, are behind R/M's seventy or more different types of packings for every industrial use.

It's "Packed with Satisfaction"—When You Use R/M



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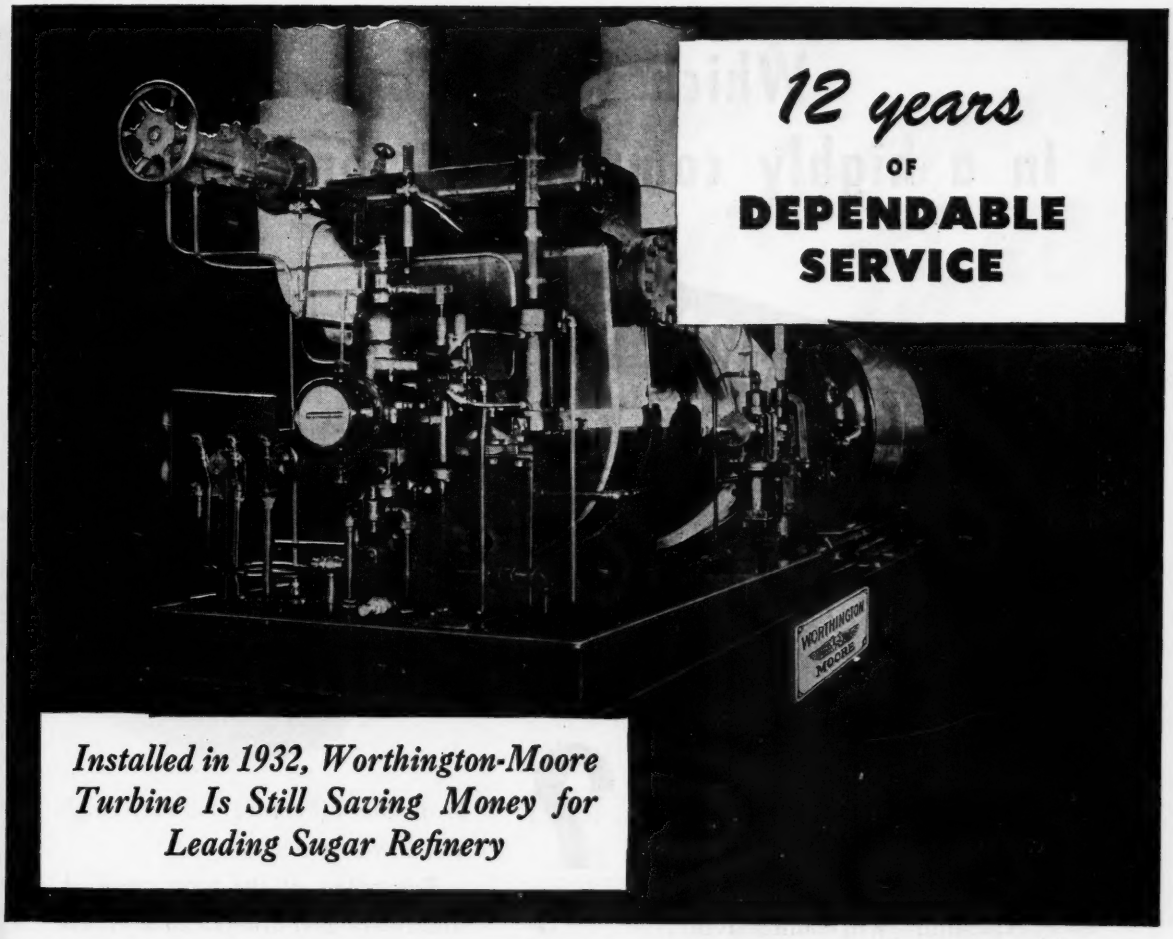

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Dan Gutleben, engineer for the Pennsylvania Sugar Company, recently wrote: "Our Worthington-Moore turbine rolls along every day and every night without stopping. It ran for years with very few shut-downs and no service expense whatever."

Electricity a By-product

This 2000 KW turbine-generator, like many other Worthington-Moore units, produces low-cost electricity as a by-product. It operates on steam at 400 lbs. pressure, 500°F. total temperature, 12 lbs. back pressure and automatically extracts steam at 90 lbs.

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Experienced in special turbine applications, as well as in a wide range of related steam power plant equipment, Worthington-Moore engineers are especially fitted to recommend the best type of unit for your particular requirements. *Worthington Pump and Machinery Corporation, Moore Steam Turbine Division, Wellsville, New York.*

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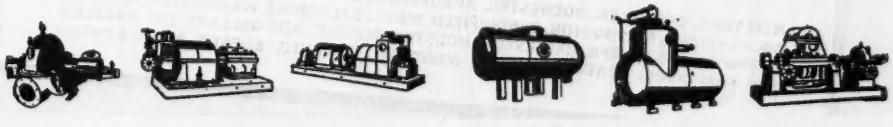

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EFFICIENT business never has money to burn — a fact that will prove doubly important tomorrow when every expenditure will count heavily in a keenly competitive market.

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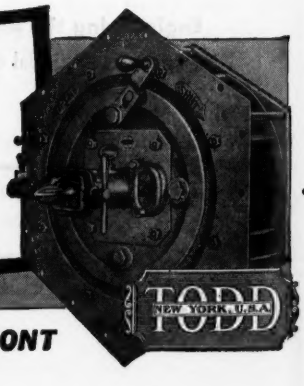
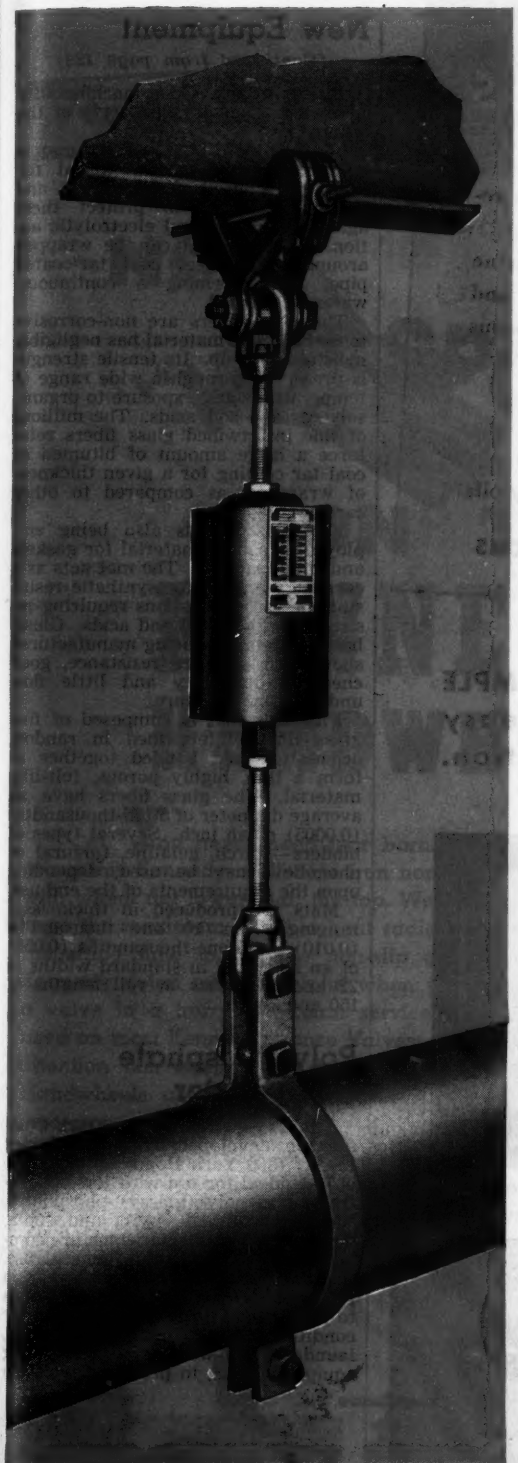


ON THE FIRING LINE OF AMERICA'S WAR PRODUCTION FRONT



Save Engineering Time

WITH GRINNELL *Pre-Engineered* SPRING HANGERS

1. Compute the load
2. Select the required stock size

When spring hangers for modern flexibly supported piping systems are "tailor-made" for each load condition, a lot of scarce engineering and drafting man-hours are required in designing. The Grinnell Spring Hanger will save this time – it is "pre-engineered for the job." The capacity you need is conveniently "packaged" – one of 14 stock sizes.

12½% MAXIMUM CHANGE IN SUPPORTING FORCE OF SPRING IN ½" VERTICAL TRAVEL--IN ALL SIZES

GUIDES PREVENT CONTACT OF COILS WITH CASING WALL OR HANGER ROD AND ASSURE CONTINUOUS ALIGNMENT AND CONCENTRIC LOADING OF SPRING

COMPACT—REQUIRES MINIMUM HEADROOM

ALL-STEEL WELDED CONSTRUCTION MEETS PRESSURE PIPING CODE

14 SIZES AVAILABLE FROM STOCK--LOAD RANGE FROM 84 LBS. TO 4700 LBS.

EASY SELECTION OF PROPER SIZES FROM SIMPLE CAPACITY TABLE

INSTALLATION IS SIMPLIFIED BY INTEGRAL LOAD SCALE AND TRAVEL INDICATORS

UNIQUE SWIVEL COUPLING PROVIDES ADJUSTMENT AND ELIMINATES TURNBUCKLE

Write for descriptive folder on Fig. 268 Pre-Engineered Spring Hangers.

GRINNELL COMPANY, INC.
Executive Offices: Providence 1, R. I.
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Atlanta 2, Ga.	Los Angeles 13, Cal.	Providence 1, R. I.
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GRINNELL
WHENEVER PIPING IS INVOLVED

ADSCO
HEAT EXCHANGERS

FOR HEATING...

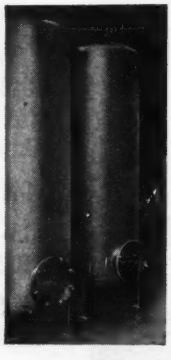
Water for Washroom service ★ Water for process requirements ★ Water for space heating systems ★ Feed water ★ Water for swimming pools ★ Brine ★ Water for air conditioning ★ Fruit Juices and other liquids ★ Molasses, oils, tars and other viscous liquids ★ Gasoline ★ Fuel Oil ★

FOR COOLING...

Condensate ★ Water for drinking water systems ★ Water for air conditioning ★ Quenching and cutting oils

FOR CONDENSING STEAM AND OTHER VAPORS

MAIL coupon for this SIMPLE FORM that makes it easy for you to get quotation.



The above is only a partial list of uses for which Adsco builds Heat Exchange equipment. If the exact purpose for which you require such equipment is not listed, chances are Adsco can build it. In some cases, your specific requirements can be met with Standard Adsco Equipment, in which case there would be certain advantages in cost and delivery. Often, however, it is necessary to design and build equipment to fill your space requirements and operating needs.

In either case you will benefit from Adsco's long experience in designing and building Heat Exchangers for a wide range of uses—experience that has given Adsco the engineering skill to analyse your problems—and recommend, or design and build the equipment to meet your exact requirements. Mail the coupon for the simple form illustrated above.

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, N. Y.

MAKERS OF "UP-TO-DATE" STEAM LINE EQUIPMENT FOR OVER 65 YEARS

A TYPE FOR EVERY PURPOSE

American District Steam Company
North Tonawanda, New York

☐ Please send REQUEST FOR QUOTATION FORM

☐ Please send me Catalog E describing Adsco Heat Exchange Equipment.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

New Equipment

(Continued from page 128)

to fungus attack. Good machinability is another important property of the laminate.

In roll form, the Fiberglas mat is being employed as a material for wrapping underground oil, gas and other pipe lines to protect them against corrosion and electrolytic action. The material can be wrapped around bitumen or coal tar-coated pipe, thus forming a continuous, water-tight bond.

The glass fibers are non-corrosive to metals. The material has negligible moisture pick-up. Its tensile strength is preserved through a wide range of temperatures and exposure to organic solvents and soil acids. The millions of fine intertwined glass fibers reinforce a large amount of bitumen or coal tar coating for a given thickness of wrapping, as compared to other carriers.

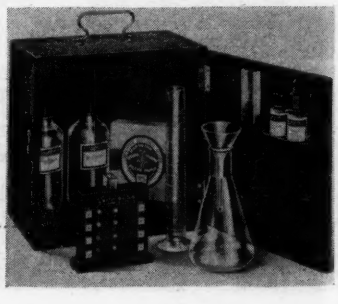
Fiberglas mat is also being employed as a base material for gaskets and sheet packing. The mat acts as a carrying medium for synthetic resins suitable for applications requiring resistance to heat, oil and acids. Glass-base gaskets now being manufactured show high pressure resistance, good chemical durability and little flow under flange pressure.

Fiberglas mat is composed of fine glass fibers intertwined in random orientation and bonded together to form a thin, highly porous, felt-like material. The glass fibers have an average diameter of 5 ten-thousandths (0.0005) of an inch. Several types of binders—starch, gelatine, furfural or phenolic — may be used, depending upon the requirements of the end use.

Mats are produced in thicknesses ranging from 10 one-thousandths (0.010) to 50 one-thousandths (0.050) of an inch, and in standard widths of 22 and 36 inches in roll lengths of 150 and 300 ft.

Poly Phosphate Comparator

THE TAYLOR POLY PHOSPHATE COMPARATOR, developed by W. A. Taylor & Co., 7300 York Road, Baltimore 4, Md., is ideal for use with low concentrations of poly (glassy) phosphates, such as hexameta, pyro, and septa, (threshold treatment) which are coming into more and more general use. Such treatments are employed in power plants and hot water systems to prevent feed line deposition; in air conditioning and refrigeration units, laundries, dish washers, milk handling equipment, etc., to prevent deposition



"Trifles make perfection but perfection is no trifle"

NO "HOT SPOT" ON THIS KENNEDY HANDWHEEL

You never need fear burned hands when you grasp this Kennedy malleable iron non-heating handwheel with wheel nut lower than the top. We have designed it to have the maximum possible heat radiating surface, and at the same time to provide non-slip grip. You'll find this Kennedy detail mighty helpful when you want to operate a valve in a hurry on steam service. This handwheel is used on most Kennedy Bronze Valves; and similarly careful attention has been given to making all other Kennedy Handwheels assure a firm, comfortable grip with ample leverage.

Not a vitally important point in valve design, but it is just one of many indications that from top to bottom, we have exerted every effort to make Kennedy Valves the kind you want to standardize on.

One of a series of advertisements explaining how Kennedy gives careful attention to the details of valve design, construction and workmanship that provide maximum effectiveness, convenience, and length of service.

THE KENNEDY VALVE MFG. CO.
ELMIRA • NEW YORK

KENNEDY valves... pipe fittings... fire hydrants

PLANS

For

PURE WATER

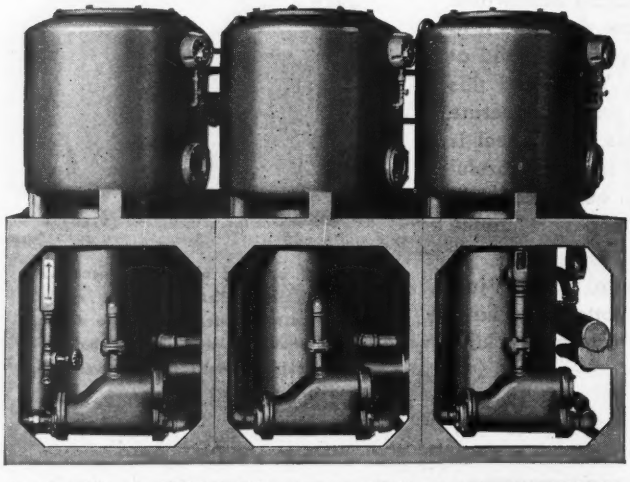
SHOULD SPECIFY

HENSZEY *Distillation* SYSTEMS

Extremely compact Henszey units can be built to any desired capacity from 3,000 to 50,000 pounds per hour—with or without integral boilers. They can be fabricated from steel, stainless steel, monel, copper or combinations of the above to meet your needs.

So if your problem is an abundance of low cost, fresh water of highest quality and purity — consider a Henszey Distillation System. Send for new bulletin No. D140 just off the press.

HENSZEY CO., Dept. C6, Watertown, Wisconsin



A 3 Effect SYSTEM with 6 Effect EFFICIENCY
A remarkable achievement of design and performance!

HENSZEY

DISTILLATION SYSTEMS

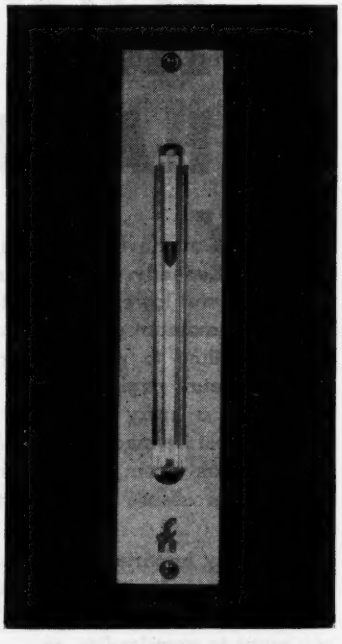
Continuous Blowdown • Heat Exchangers • Boiler Feed Regulators
Feed Water Meters • Flow Indicators • Proportioning Valves

and corrosion; in municipal and process water to stabilize the water and prevent corrosion (redwater); in photography to prevent deposition on film and paper, etc. A simple rapid and accurate method of analysis is therefore imperative.

By the Taylor method a complete determination requires only 20 min. After conversion, two reagents are added separately and the blue color formed is compared with the standards. This gives the total phosphate content. A determination on the cold sample (no boiling) gives the ortho present in the sample. The difference is the poly phosphate.

Panel-Mounted Rotameter

DESIGNED TO ANSWER the growing need for panel centralization of instruments that indicate pressure, flow, temperature, etc., the new Schutte & Koerting panel-mounted Rotameter is



basically the S-K Universal Rotameter, the panel-mount has a frosted glass window with a central clear-glass aperature and is installed flush in the panel-board, with the Rotameter supported directly behind. Provision is made for adequate backlighting and ready maintenance accessibility.

Screw Pump for Thick Liquids

SIER-BATH GEAR CO., 9256 Hudson Blvd., North Bergen, N. J., has just introduced a new displacement pump of the screw type, ideally suited to most heavy duty pumping. It will handle thick liquids of both the lubricating and non-lubricating type, such as asphalt, greases, soaps, and syrups.

WE KNOW THE PIPING PROBLEMS

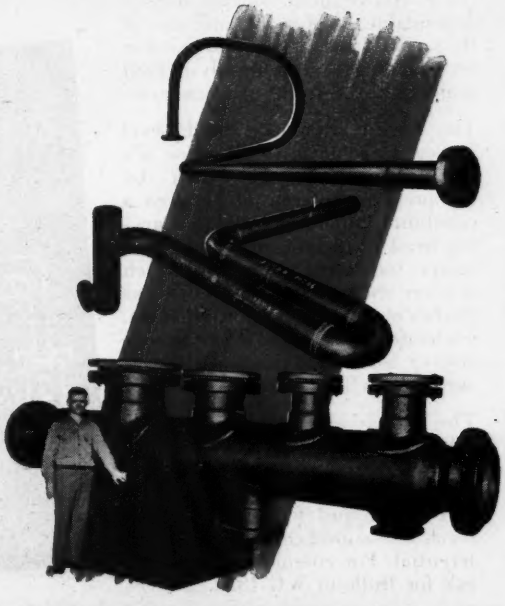
from BOTH SIDES of the Desk

Midwest not only fabricates piping for all purposes, but also operates an experienced contracting department that will deliver to the customer a completely installed piping system—ready for operation. Consequently, we have a clear view of piping problems from both sides of the desk.

Our contracting department is ever ready to make *practical* suggestions for improving pre-fabricated piping subassemblies. This continuous interchange of information and suggestions helps keep the entire Midwest organization on its toes; it is important in maintaining the high quality of Midwest piping.

Our contracting department is in constant and intimate touch with piping users in all types of industry. Changes in piping requirements . . . changes in the thinking of users are quickly relayed throughout the entire Midwest organization.

Midwest has four modern pipe fabricating plants strategically located to serve you . . . whether you need a simple bend or piping for an entire plant completely erected and ready for operation.



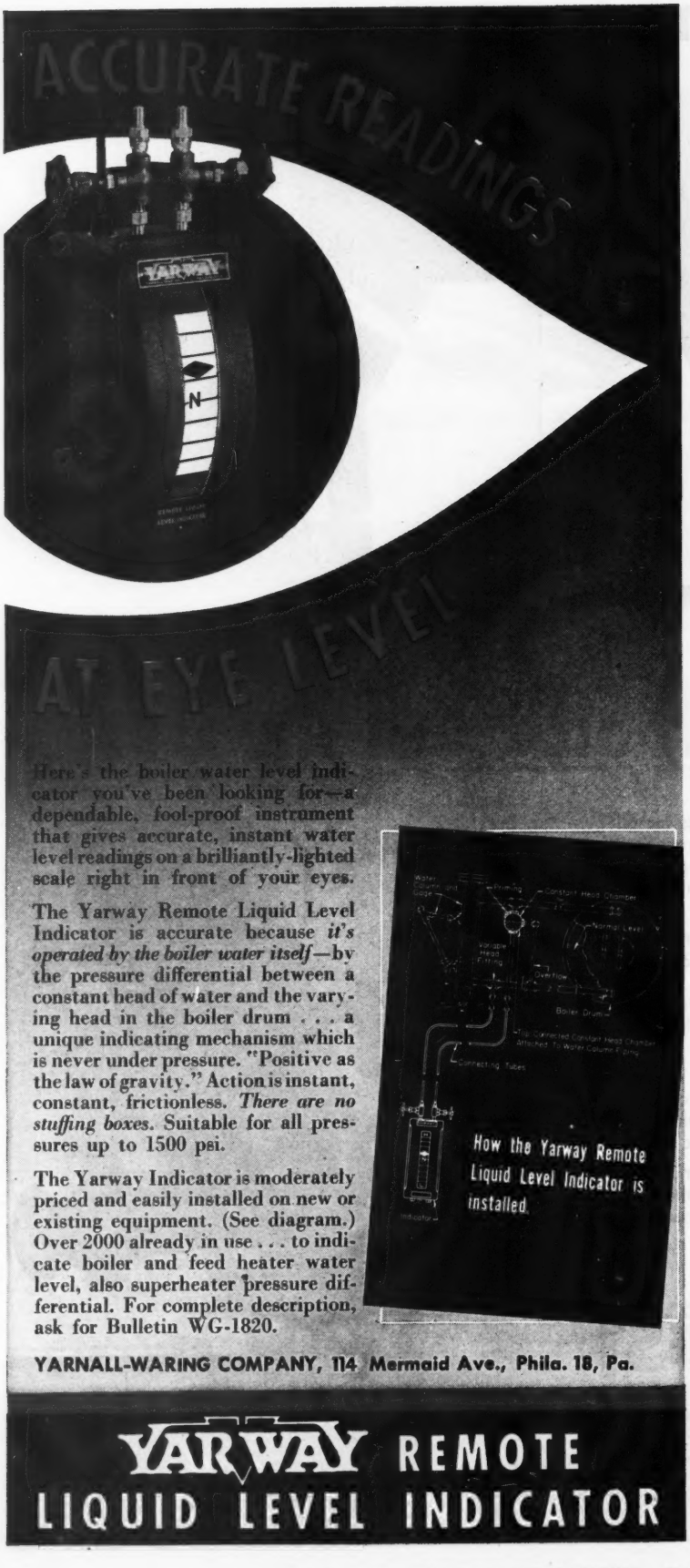
MIDWEST

PIPING & SUPPLY CO., INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • Subsidiary: Lumsden & Van Stone Co., South Boston 27, Mass. • Sales Offices: New York 7—(Eastern Division) 30 Church St., Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—426 First St.

Piping Fabricators and Contractors


ACCURATE READINGS
YARWAY
N
AT EYE LEVEL
Here's the boiler water level indicator you've been looking for—a dependable, fool-proof instrument that gives accurate, instant water level readings on a brilliantly-lighted scale right in front of your eyes.
The Yarway Remote Liquid Level Indicator is accurate because *it's operated by the boiler water itself*—by the pressure differential between a constant head of water and the varying head in the boiler drum . . . a unique indicating mechanism which is never under pressure. "Positive as the law of gravity." Action is instant, constant, frictionless. *There are no stuffing boxes.* Suitable for all pressures up to 1500 psi.
The Yarway Indicator is moderately priced and easily installed on new or existing equipment. (See diagram.) Over 2000 already in use . . . to indicate boiler and feed heater water level, also superheater pressure differential. For complete description, ask for Bulletin WG-1820.
Boiler Drum
Connecting Tubes
How the Yarway Remote Liquid Level Indicator is installed.
YARNALL-WARING COMPANY, 114 Mermaid Ave., Phila. 18, Pa.
YARWAY REMOTE
LIQUID LEVEL INDICATOR

Since there is no pulsation or vibration in the flow from this pump, it is particularly suited for handling bunker C fuel oil in burner operation. This feature also prevents the frequent loosening of piping that occurs from the impact of a pulsating flow.

The only regular maintenance requirement is an occasional packing ring renewal which can be made while the pump is in service. Self-centering herringbone timing gears prevent sidewear of screws resulting from contact while pumping. The end to center flow of fluid in the horizontally mounted units eliminates thrust bearings.

New ENGINEERING BOOKS

Light, Vision and Seeing. By Matthew Luckiesh. Copyright 1944, first edition, 5½ by 8½, 323 pages, stiff cloth binding. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York City. Price $4.50.

The author who is director of the Lighting Research Laboratory, General Electric Company, Nela Park, Cleveland, Ohio, has for more than 30 years been conducting research in the subjects of light, vision and seeing and has published many books dealing with subjects closely related to the title of this book which deals with all the controllable factors which make seeing easy. The author has prepared the book in rather a popular style making it easy reading for non-technical persons but has given in its pages a vast amount of information which is little known to those outside laboratories dealing with light problems. The book is extremely interesting reading. The author covers the subject in 17 chapters every one of which deals with subjects of great importance to all who have eyes with which to see, for he gives directions throughout the entire book for the care of the eyes through the arrangement of light, its intensity and reflections, color or contrasts, and all phases of the subject which have been subjected to research studies during the past generation. It is a book we can all read with profit.

Stoker Manufacturers' Association Technical Manual. Prepared by Stoker Manufacturers' Association Engineering and Research Committee. First Edition, copyright 1944, 9 by 11 inches, paper bound, prepared for insertion in loose leaf cover. Published by the Stoker Manufacturers' Association, 307 North Michigan Avenue, Chicago 1, Ill. Price $1.

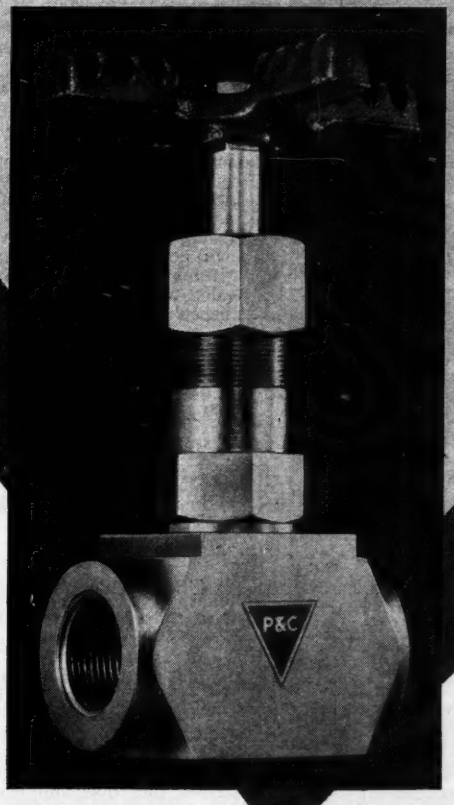
In the foreword of this new technical manual it is stated that greater than the separate products of any individual member of the Stoker Manufacturers' Association is the service these manufacturers represent collectively. In keeping with this thought the Association has prepared the material contained in this manual on the selection of stokers and boilers or furnaces for stoker firing, industry standards, recommended practices and general engineering and technical data. In publishing this manual the Association has followed closely to its

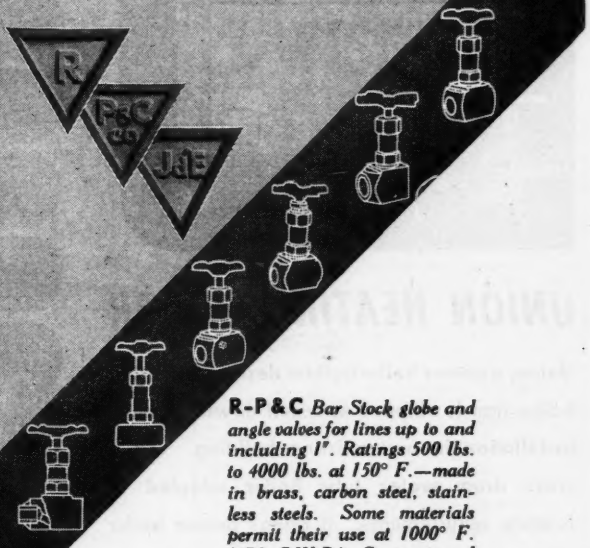
There's a *Story* behind this fine Valve

It is designed for severe throttling service. It is precision-made of rigidly controlled materials—for high working pressures. It is a Bar Stock valve—originated, developed and improved by **R-P&C** engineers. But that is only a part of the story.

This fine valve is one of a line that is still made under the "high working pressure" of wartime demands—in spite of the "severe throttling" of wartime shortages. And yet these Bar Stock valves are the best ever produced by **Reading-Pratt & Cady.**

It is a fact that **R-P&C** are making better valves today than ever before. We believe that's worth remembering next time you need valves.





R-P&C *Bar Stock globe and angle valves for lines up to and including 1". Ratings 500 lbs. to 4000 lbs. at 150° F.—made in brass, carbon steel, stainless steels. Some materials permit their use at 1000° F. (475 S.W.P.) Compact and sturdy for their ratings—low in price for their superior performance and long life.*

R-P&C offers you a single responsible source for bronze, iron and steel gate, globe, angle and check valves—cocks and Lubrotite gate valves—bar stock valves—cast steel fittings—D'Este Automatic Valves and Engineering Specialties.

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MANUFACTURERS OF
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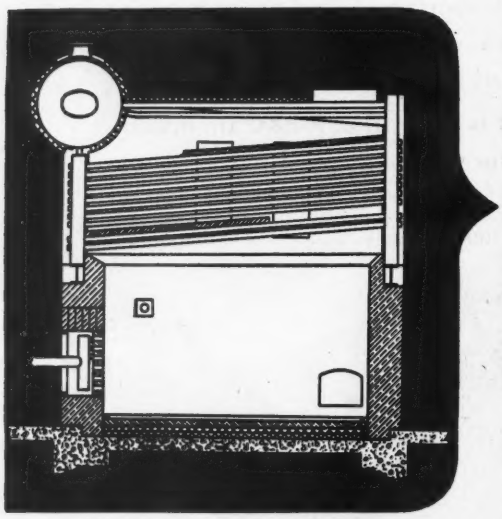
FILE THESE UNION ADS FOR REFERENCE



H-TYPE
A-TYPE
HEATING
RADIANT TYPE
4-DRUM
O-TYPE
LONG DRUM
CROSS-DRUM
UNIVERSAL STEEL-CASED
UNIVERSAL BRICK-SETTING
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UNION HEATING BOILER

Union, a power boiler builder designs a heating boiler that is shipped knocked down for easy installation in any existing building. It's a cross drum water tube boiler adapted to heating requirements. It brings power boiler efficiencies to heating demands. All water is preheated in the side wall headers before entering the boiler proper. As compared with any fire tube heating boiler, the Union Water Tube Heating Boiler offers greater furnace volume, better efficiency and greater capacity.

Write for booklet today.

UNION IRON WORKS • ERIE, PA.

BOILERS

PRESSURE VESSELS • PLATE FABRICATION

aims and has condensed a lot of very helpful information into a few pages which should be helpful to purchasers and users of stokers in making their selections and in checking up on performance and installation of stokers. The manual is full of tables and charts which are based on present day practice and will be found helpful particularly in plants where stokers of moderate size are installed.

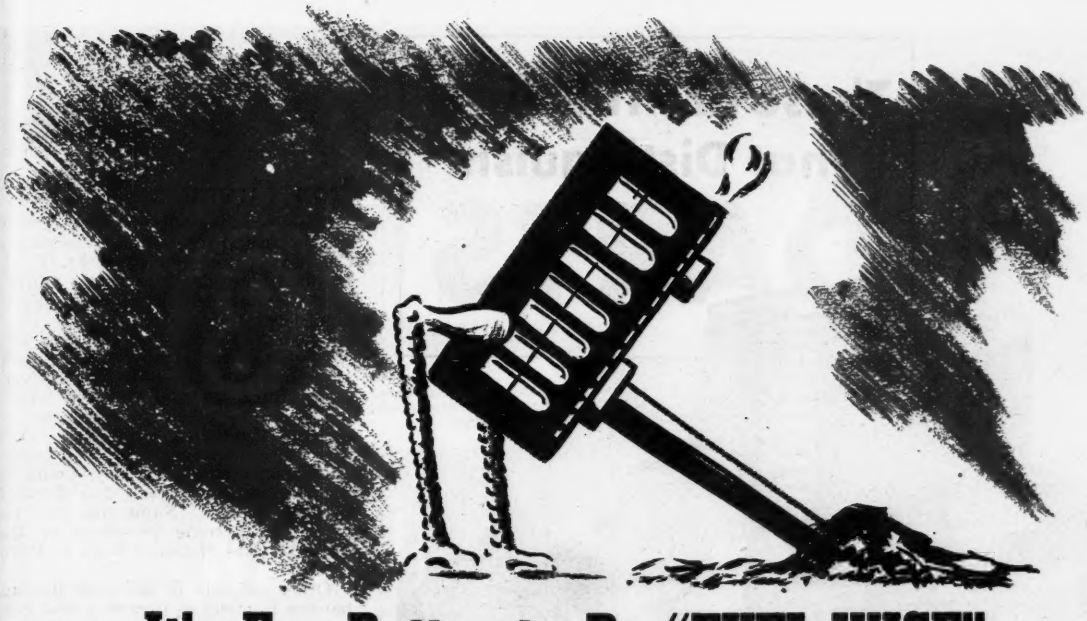
ASTM Standards on Coal and Coke. By ASTM Committee D-5 on Coal and Coke. Copyright 1944, 4 by 9 inches, 124 pages, paper binding. Published by the American Society for Testing Materials, 260 S. Broad Street, Philadelphia 2, Penn. Price $1.50.

This carefully prepared pamphlet includes five specifications, 24 methods of testing and evaluation, and six definitions. A major portion of standards relate to coal, with standard methods covering sampling and analysis, fineness (powdered coal), grindability, etc.; for coke, tests include drop shatter, sieve analysis, etc. Specifications include widely used standards covering classification of coals by rank and by grade, sieves for testing purposes, and requirements on gas and coking coals. This publication is one of a number of special compilations relating to specific fields including all of the specifications and tests as developed by the ASTM through the work of its various technical committees. The pamphlet constitutes a complete manual giving detailed directions for sampling coal and coke, performing chemical analysis, making tests to determine physical characteristics, classifying and specifying coals and coke, and should be extremely helpful to all engineers who must specify or test fuels.

Marine Pipefitting. By Vern E. Hase and Ralph W. Allen. Copyright 1944, 6 by 8-in., 325 pages, stiff cloth binding. Published by McGraw-Hill Book Co., 330 W. 42nd Street, New York, N. Y. Price, $3.00.

The authors of this practical book on pipefitting have been instructors of hundreds of people taking training in marine pipefitting at the Puget Sound Navy Yard and became convinced of the necessity for a down-to-earth, on-the-job textbook for these workers. The constant goal set before them was to write a book from the viewpoint of the man on the job. This book, therefore, covers actual jobs encountered in marine pipefitting, describes the tools and materials used, and depicts conditions and problems actually encountered in ship and shop-work. In addition the authors include material of a technical nature so that the book can be utilized by an experienced mechanic for reference purposes. While the book is designed principally for men working in the marine field, it will be found highly useful in any power plant or industrial plant where piping is used extensively.

The first two-thirds of the book is devoted to the practical work of pipefitting; the tools and materials used; steam, water and oil systems employed; silver brazing; lead work and piping layouts. The final third of the book is more technical with four chapters on mathematics and their application to piping layout work.



It's Far Better to Be "FUEL-WISE"

It's going to be tough for those plants which are unwilling to face the future competitive era from a realistic viewpoint, because the fuels pattern is changing and coals from present primary sources may not be available.

If you are not certain as to the proper course to pursue in your planning for the future, just ask yourself such questions as these:

.... Is my combustion equipment flexible?
.... Are my stokers or pulverizers adequate to carry full boiler load with *any available* low-cost coal?
.... Is my furnace amply large for full load and smokeless combustion with *all available coals?*

If you can't answer these questions or if you must say "No," then it's time to be "Fuel-Wise" and consult Fairmont Coal Bureau engineers. Now is the time to think ahead and be ready *before* it's too late.

Valuable data pertaining to coal and its relation to plant operating costs are available in "Coal Reference Bulletins" which will be sent promptly on request. Ask to be placed on our mailing list. Fill out and mail coupon today.

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LOW FUSION FAIRMONT COAL IS THE COAL FOR THE "FUEL-WISE"

because

.... it can be economically burned in any equipment properly engineered for its use.

.. its huge reserves assure its availability for many years to come.

.. it assures the lowest overall steam cost for the plant that is engineered for its use.

.... it effects savings in coal dollars that quickly pay for the changes necessary to burn it efficiently and economically.

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Kindly place me on your mailing list to receive copies of "Coal Reference Bulletins." It is understood these will be sent FREE and without obligation.

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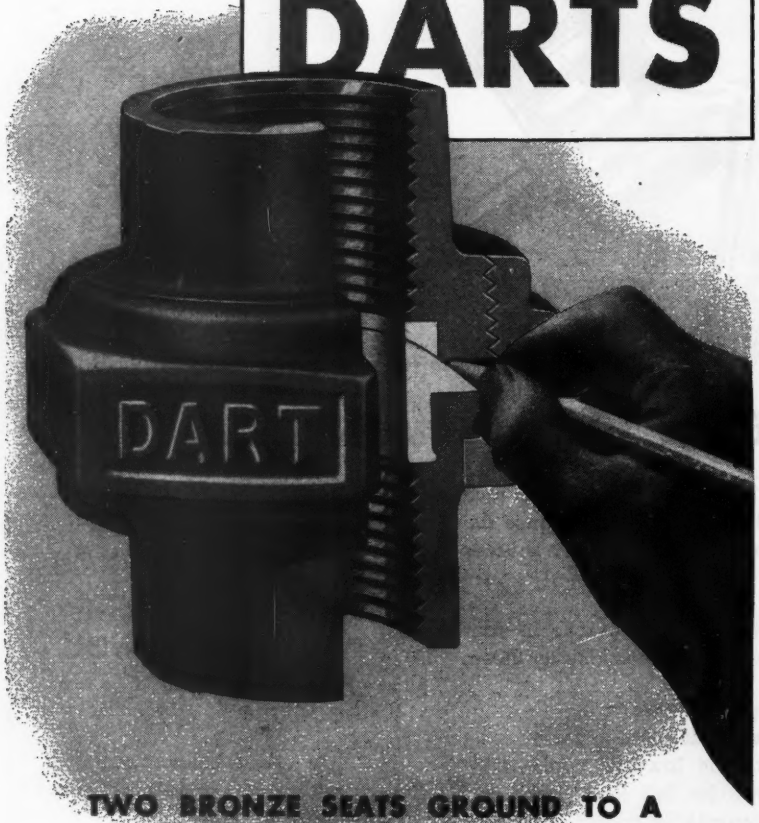
These are The Parts That Distinguish DARTS



TWO BRONZE SEATS GROUND TO A TRUE BALL JOINT

This feature distinguishes the Dart Union from all others—it has two bronze seats, which are perfectly ground to form a trueball joint. It will stay put—leakproof—indefinitely; yet may be uncoupled instantly whenever you have a new job for it. Body and nut—made of high-test air-refined malleable iron—are practically unbreakable. In length of trouble-free service, Darts cost less. Order from your supplier.

E. M. DART MFG. CO.
PROVIDENCE, RHODE ISLAND

DART UNIONS LIVE LONGER

MANUFACTURERS' *News*

Iron Fireman Officers

Changes in the officers and directors of the Iron Fireman Manufacturing Co. have been announced by T. H. Banfield, president, after the directors' meeting held April 17, in Portland, Ore.

Frank S. Hecox, who has been secretary-treasurer, is now vice president and treasurer, as well as director. C. T. Burg, general sales manager, becomes vice president in charge of sales and remains a director. Clifford W. Snider, who has been comptroller, was made secretary. Omar C. Spencer has been elected a director in place of E. C. Sammons, who resigned to become president of the United States National Bank in Portland.

Other officials in the new line-up, besides Banfield as president and general manager, are Mansel P. Griffiths and T. Henry Boyd, directors. Omar C. Spencer will serve as assistant secretary.

Banfield, with C. J. Parker, founded the company in 1923, and has headed the business since the death of Parker in 1927.

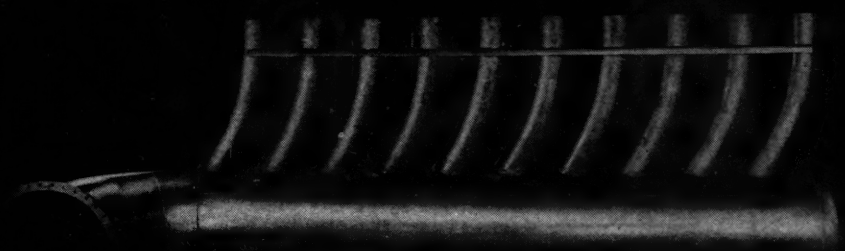
Westinghouse Changes Name

Stockholders of the Westinghouse Electric and Manufacturing Co. at their recent annual meeting voted to split the Company's stock on the basis of four shares for one and also to change the Company's name to Westinghouse Electric Corp., for simplicity and brevity. The purpose of the stock split is to broaden the base of Westinghouse ownership by making the stock available at a lower price. There are now about 48,000 Westinghouse stockholders, and none owns more than one and one-half per cent of the stock.

The stockholders also elected seven present directors to the sixteen-man Board. Four were elected for four-year terms. They are: George H. Bucher, President of Westinghouse; W. C. Robinson, President of the National Electric Products Corp.; Arthur W. Page, Vice President of the American Telephone and Telegraph Co.; and Robert T. Swaine, senior member of the law firm of Cravath, Swaine and Moore. H. B. Higgins, President of the Pittsburgh Plate Glass Co., was elected for three years. Named for one-year terms were Gwilym A. Price, Westinghouse Vice President, and John R. Read, Chairman of the Board and President of the Canadian Westinghouse Co.

Babcock & Wilcox Elects J. H. King and Alfred Iddles Vice Presidents

Auguste G. Pratt, president of The Babcock & Wilcox Co. has announced the election of two additional vice presidents, Alfred Iddles and J. H.



Safety Valve Piping. 42" O. D. Header with 10-12" inlet connections.

NAVCO
Pre-Fabricated Piping

means
ACCURACY•DEPENDABILITY

Desuperheated Safety Valve Discharge Header 30" O.D. outlet, with 6-12" welded inlet.

Turbine Exhaust Vent Hood. Outlet 20" O. D., with 4-10" inlets.

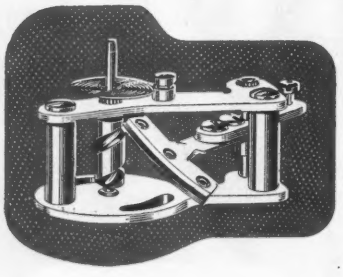
There are many advantages in shop fabricating such assemblies as shown here. Better control of welding is afforded — Economies are effected — Closer tolerances can be maintained. The extensive facilities of Navco Shops insure reasonable deliveries even in these days of Defense Programs and Priorities.

NATIONAL VALVE & MFG. CO.
Pittsburgh 1 Pennsylvania

NAVCO

NAVCO PIPING

DO YOU HAVE SUDDEN SHOCKS?



If you have pressure gauges which are subject to sudden shocks, on releases of pressure, then Certified are the gauges for you. On hydraulic presses, the sudden release of pressure just about ruins the ordinary gauge with geared teeth.

But with Certified Gauges, a sudden release of pressure merely releases the cam from the Helicoid movement roller and that's that. No harm can come to the gauge. The force of the pointer against the stop pin is only that exerted by the hair spring. You get the same protection if your pressure gauges are subjected to vacuum as on turbine and condenser service. This is possible only with the Helicoid movement. And the Helicoid movement is used only in Certified Gauges.

All Certified Gauges are guaranteed accurate to within ½ of 1% of the scale range. They remain accurate longer.

Certified GAUGE
AND INSTRUMENT CORP.

34-13 Northern Boulevard — Long Island City 1, New York

8-CG-2

King. Mr. King has been manager of the Marine Department of the Company since 1932, and Mr. Iddles, special assistant to the vice president in charge of engineering.

Mr. Pratt was re-elected president, and Isaac Harter, E. G. Bailey and C. W. Middleton re-elected as vice presidents. A. E. Phin was re-elected comptroller, and William Sheldrick treasurer and assistant secretary. C. U. Savoye has been appointed as an additional Executive Assistant.

Mr. Iddles, who lives at 203 Orchard Way, St. Davids, Pa., has been associated with the Company since 1937, and has had charge of the service and service engineering department which provides the functional design of boilers and fuel-burning equipment. In 1919 he was with the Bureau of Mines, Fuels Division, in Pittsburgh, and before coming to The Babcock & Wilcox Co. he was a vice president of United Engineers and Constructors in Philadelphia, in charge of design and construction work of all kinds throughout the United States, in Canada and South America.

Mr. King has been manager of the marine department of the Company since 1932, having served as assistant manager of the department for three years prior to that time. As vice president he will continue to head the Company's marine activities having direct charge of the firm's extensive program of furnishing marine boilers for the Navy and Maritime Commission war schedules. Mr. King has been associated with the Company since 1914, when he entered its employ as an apprentice engineer in the Bayonne (N. J.) works.

Wire Rope Slings to Be Registered

American Chain and Cable Co., Inc., Bridgeport, Conn., has recently announced on behalf of its two wire rope divisions, the American Cable Division and the Hazard Wire Rope Division, that their several types of wire rope slings may now be accompanied by a certificate of test and registry for the benefit of the sling user. The policy of selling registered slings is new to the wire rope industry.

All registered slings are made from preformed wire rope of improved plow steel. All registered sling terminals develop the full strength of the sling body. Many registered slings will carry the new ACCO-LOC Safety Splice. The ACCO certificate of test and registry furnished a permanent record of the original strength rating of the sling, the safety factor upon which that rating was based, the actual proof load, and conditions of the sale. Each sling carries a metal tag which shows registry number, sling type, and maximum load rating.

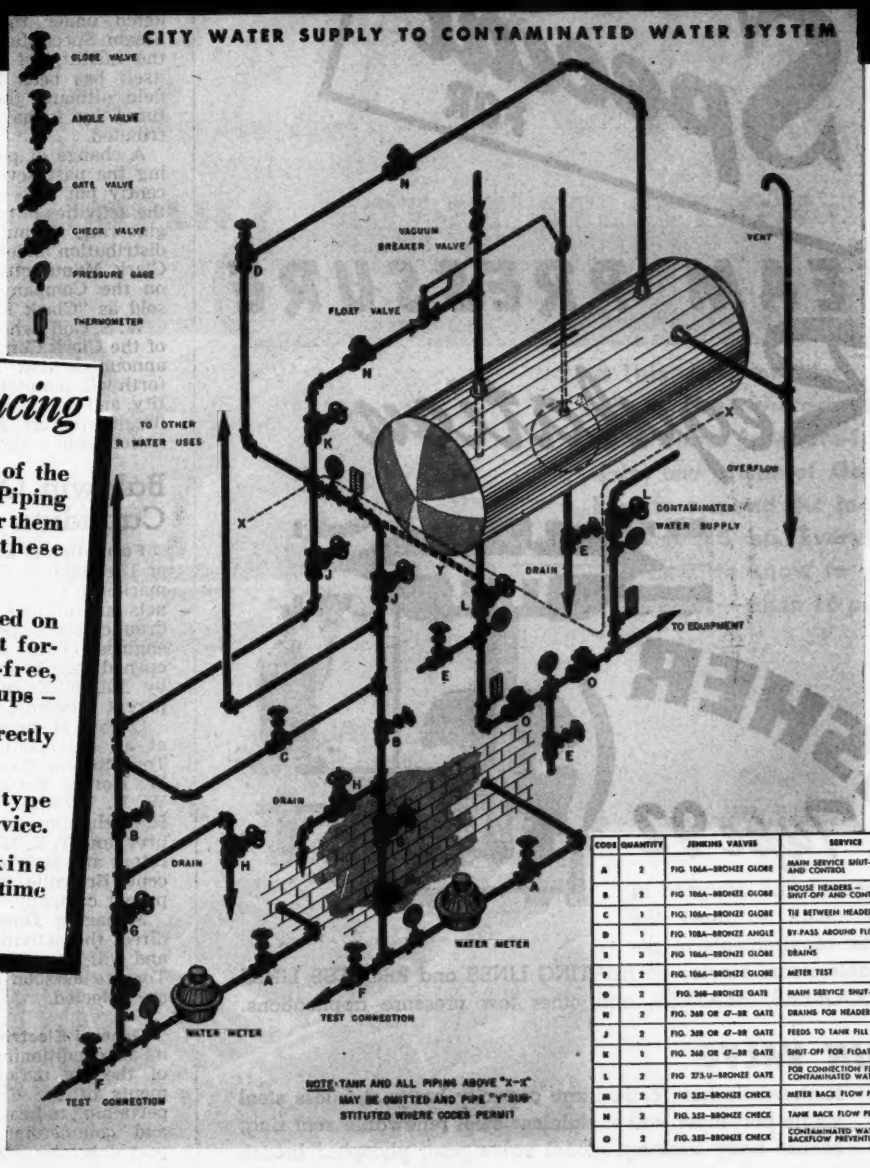
This registered program includes all of the following types of wire rope slings—the conventional wire rope slings, braided wire rope slings and cable-laid slings.

Clark Fluid Controls

During the past 37 years, steam and vacuum traps, pressure regulators, separators, and other steam specialties have been manufactured by the

Jenkins PRACTICAL PIPING LAYOUTS 1

CITY WATER SUPPLY TO CONTAMINATED WATER SYSTEM



CODE	QUANTITY	JENKINS VALVES	SERVICE
A	2	FIG. 106A—BRONZE GLOBE	MAIN SERVICE SHUT-OFF AND CONTROL
B	2	FIG. 106A—BRONZE GLOBE	HOUSE HEADERS — SHUT-OFF AND CONTROL
C	1	FIG. 106A—BRONZE GLOBE	TIE BETWEEN HEADERS
D	1	FIG. 108A—BRONZE ANGLE	BY-PASS AROUND FLOAT VALVE
E	3	FIG. 106A—BRONZE GLOBE	DRAINS
F	2	FIG. 106A—BRONZE GLOBE	METER TEST
G	2	FIG. 368—BRONZE GATE	MAIN SERVICE SHUT-OFF
H	2	FIG. 368 OR 47—BR GATE	DRAINS FOR HEADERS
J	2	FIG. 368 OR 47—BR GATE	FEEDS TO TANK FILL LINE
K	1	FIG. 368 OR 47—BR GATE	SHUT-OFF FOR FLOAT VALVE
L	2	FIG. 273-U—BRONZE GATE	FOR CONNECTION FEEDING CONTAMINATED WATER SUPPLY
M	2	FIG. 252—BRONZE CHECK	METER BACK FLOW PREVENTION
N	2	FIG. 252—BRONZE CHECK	TANK BACK FLOW PREVENTION
O	2	FIG. 252—BRONZE CHECK	CONTAMINATED WATER SUPPLY BACKFLOW PREVENTION

Introducing

A NEW SERIES of the popular Jenkins Piping Layouts. Watch for them each month in these pages.

Each layout is based on the proved 3-point formula for trouble-free, time-defying hookups –

1. **Place valves correctly in the lines.**
2. **Use the right type valve for the service.**
3. **Choose Jenkins Valves for lifetime economy.**

City and State Laws require that contamination of city water be made impossible when a secondary, impure source of water is used for cooling, boiler feed, etc. This layout presents an economical hookup to meet all requirements. Local codes vary, and obviously could not all be allowed for. Jenkins recommends consultation with accredited engineers and contractors when adapting these suggestions to your specific requirements. **Copies of This Layout No. 1,** enlarged, with complete details of all valve specifications, will be furnished on request by Jenkins Engineers.

OVER 600 JENKINS VALVES TO FIT YOUR PLANS

When you plan your piping layouts, you will rarely need a valve you can't find in the JENKINS CATALOG. Over 600 patterns are listed, for every type of service.

That means you save time – by selecting all the valves you need from one source. It also means you get the advantages of Jenkins *better* design, *better* materials, and *better* workmanship for every control point on your lines . . . at no higher cost than for other good valves.

Jenkins Bros., 80 White Street, New York 13; Bridgeport; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Ltd., Montreal; London, England.

LOOK FOR THIS TRADE JENKINS MARK **DIAMOND MARK**

SINCE 1864 *Jenkins Bros.*

JENKINS VALVES

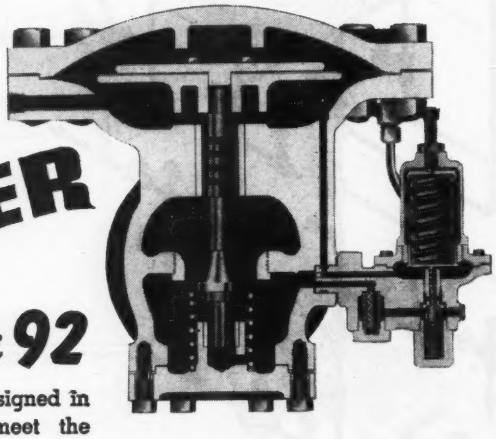
BRONZE • IRON • STEEL AND CORROSION-RESISTING ALLOYS

For every industrial, engineering, marine, plumbing-heating service . . . 125 to 600 lbs. pressure.

Sold Through Reliable Distributors Everywhere

A Special FOR

STEAM PRESSURE Regulation



FISHER Type 92

Engineered and designed in every detail to meet the specific requirements of dependable steam service on HEATING LINES and PROCESS LINES TO COOKERS, HEATERS, and other low pressure applications.

MAIN VALVE

High-tensile iron, extra large capacity body; stainless steel single port inner valve; stainless steel renewable seat ring; bronze body bushing; monel valve post; phosphor bronze diaphragm; Inconel spring.

PILOT VALVE

High-tensile iron body; hardened stainless steel inner valve and seat ring; phosphor bronze diaphragm; Inconel pilot valve spring.

PLUS THESE OUTSTANDING FEATURES:

Two interchangeable pilot valves for high or low pressure service. Single port construction provides tight shut-off for dead end service. Compact design — requires minimum installation space. Working parts readily removed without breaking pipe line connections.

Available in sizes ½" to 6" for reduced pressures up to 200 lbs.

Write today for Bulletin C1.

FISHER GOVERNOR COMPANY

1026 Fisher Bldg., MARSHALLTOWN, IOWA

Clark Manufacturing Co., 1830 East 38th St., Cleveland, Ohio, and marketed under the name of "Strong Steam Specialties." For this reason, the identity of the Clark company itself has been little known in the field, although the products manufactured by it have been widely distributed.

A change of policy, developed during the past several months and recently put into action, brings all of the activities of product designing, engineering, manufacturing, sales and distribution under the one roof of The Clark Manufacturing Co. From now on the Company's products will be sold as "Clark Fuild Controls."

W. S. Goff, who assumed presidency of the Clark Company 18 months ago, announces that the concern henceforth will maintain its individual identity, and that it will deal directly with its distributors and customers on a nation-wide scale.

Baldwin Organizes Canadian Subsidiary

Formation of a Canadian subsidiary of The Baldwin Locomotive Works to market in Canada such Baldwin products as turbines, water wheels, hydraulic presses, power tools and Diesel engines from headquarters to be opened soon in Toronto, is announced by Ralph Kelly, president of the parent company.

Officers of the new company, elected at an organization meeting held in Toronto, are Ralph Kelly, president; W. Horace Holcomb, vice president; W. N. Brownlie, managing director; H. D. Humphreys, secretary and treasurer; and T. E. McFalls, assistant secretary and assistant treasurer. All except Brownlie are officers of the parent company.

Managing Director Brownlie, will direct the activities of the subsidiary and will establish his headquarters in Toronto as soon as suitable quarters are selected.

General Electric Co., has established its air conditioning department as one of the six major operating departments of the Company. Operations pertaining to heating, air conditioning, and commercial refrigeration have previously been the responsibility of the company's appliance and merchandise department. The new department will have its headquarters at Bloomfield, N. J., and George R. Prout has been designated as general manager.

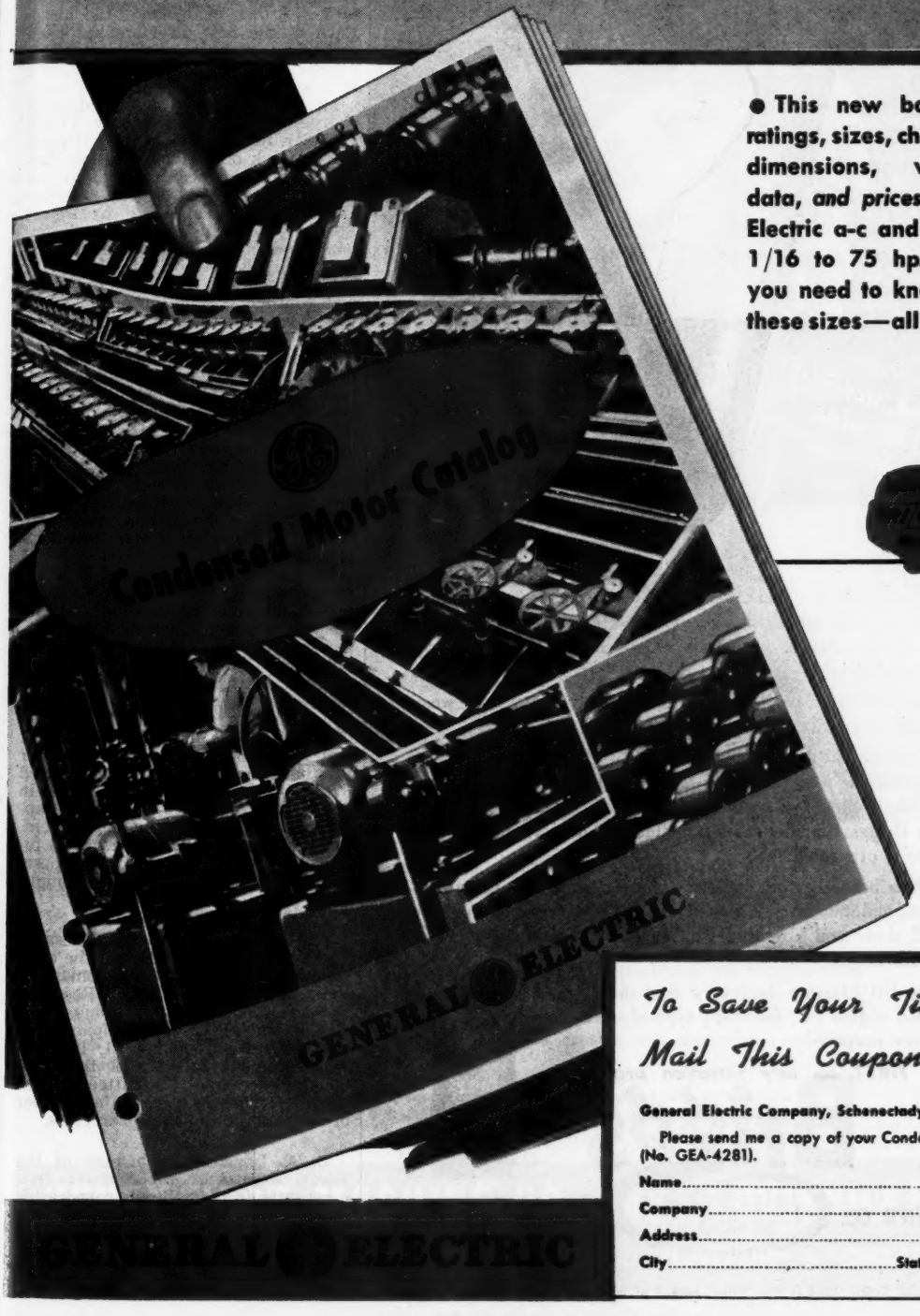
This department will select and utilize appropriate marketing channels and methods for all of its products except air conditioning for rail transportation, which remains a responsibility of the transportation divisions of the Company.

Thomas Robins, Jr. was elected president of Robins Conveyors, Inc., by board members meeting in Passaic on April 19. He succeeds Thomas Matchett, president since 1928, who announced that he is retiring from an active part in the management.

Thomas Robins, Jr., has been chairman of the executive committee for the past five years. Also he is president of Hewitt Rubber Corp. in Buffalo. Prior to moving to Buffalo he

BOILED DOWN

TO SIMPLIFY MOTOR SELECTION



● **This new booklet gives ratings, sizes, characteristics, dimensions, where-to-use data, *and prices* of General Electric a-c and d-c motors, 1/16 to 75 hp. Everything you need to know to select these sizes—all in 16 pages!**

Buy all the BONDS you can—*and keep all you buy*

To Save Your Time Later Mail This Coupon Today—

General Electric Company, Schenectady 5, N. Y.

Please send me a copy of your Condensed Motor Catalog (No. GEA-4281).

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Company.....

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GENERAL ELECTRIC

Intense heat, high pressures, violent agitation cause weaker molecules in oil to break down—become susceptible to oxidation and polymerization—form gums, resins, asphaltenes. When this happens, oil becomes tired . . . unable to do its vital job.

Result—piston lacquering, bearing failures, premature engine wear, increased upkeep and excessive oil consumption.

Briggs Oil Clarifiers prevent the disastrous results of tired oil. They remove the visible contaminants in oil . . . dust, metal chips and grit. They remove the invisible products of oxidation . . . gums, resins, asphaltenes. Oil clarified in a Briggs Clarifier does a better job longer, maintenance is lowered, trouble is prevented.

Ask the Briggs Distributor in your locality for the facts about the advantages of continuous maintenance of lube oil, the importance of clean Diesel fuel oil. He will show you how and why Briggs Clarification goes far beyond ordinary filtration.

There is a Briggs Oil Clarifier for every size and type internal combustion engine . . . for every type of oil . . . for practically every purpose.

Consult Briggs FIRST on any filtration problem.

ARMY NAVY

Briggs

PIONEERS IN MODERN OIL FILTRATION

BRIGGS CLARIFIER CO. **Washington 7, D. C.**

Representatives in Principal Cities—listed in the "Filter" section of most classified telephone directories

was associated with Robins Conveyors for seven years immediately following the first World War. He is vice chairman of the board of directors, National Synthetic Rubber Corp., Louisville, Ky., also a director of the Federal Reserve Bank of New York, Buffalo Branch, the Marine Trust Co. of Buffalo and Niagara Share Corp. Currently he is vice president of the Buffalo Chamber of Commerce.

The election of William L. Martwick, Lee A. Swem and Charles E. McCulloch as directors of Foster Wheeler Corp. has been announced by J. J. Brown, chairman of the board. Each of the new directors has been associated with the Corporation for several years and is well known throughout the industry.

Mr. Martwick is vice president in charge of general sales for Foster Wheeler. After spending several years in the work of fuel preparation, furnace design and combustion, he became president of the Aero Pulverizer Co., which was absorbed by Power Specialty Co. in 1926. The latter company then organized a pulverizer and furnace division with Mr. Martwick as manager, an arrangement which was continued after Power Specialty was succeeded the following year by the Foster Wheeler Corp. In 1932 Mr. Martwick went to Chicago as director of Foster Wheeler's western offices and five years later was appointed general sales manager with headquarters in New York. He has been a vice president since 1940.

Mr. Swem has been the Corporation's patent counsel since May, 1936, and before that, while engaged in the practice of law devoted a considerable part of his time to Foster Wheeler's patent problems.

Mr. McCulloch, the third new director, manager of Foster Wheeler's petroleum refinery division for the past eight years, has had a wide experience in the field of chemical engineering. After graduating from Massachusetts Institute of Technology in 1926, he joined the National Carbon Division of the Union Carbide and Carbon Corp. as an analytical chemist and later become chemical engineer for the Tidewater Oil Co. He joined Foster Wheeler's refinery division in 1927 and ten years later was appointed manager of the department, in which position he has gathered together a corps of outstanding experts in the many phases of this complicated work.

The Board of Directors of Monsanto Chemical Co. has announced the election of Dr. Charles Allen Thomas, director of Monsanto's Central Research Laboratories at Dayton, Ohio, as a vice president of the company and that, effective September 1, 1945, he will become a member of the company's executive committee. Since 1942, Dr. Thomas has been a member of Monsanto's Board of Directors.

C. A. Laystrom, chairman of the Board of Directors of Laystrom, Inc., a recently formed Illinois corporation with offices at 231 South LaSalle Street, Chicago 4, Ill., has announced that Laystrom, Inc. has acquired control of Geo. B. Limbert & Co. There will be no change in management,

STRENGTH

FOR SAFETY AND LONG-TIME SERVICE

Specify

Vogt

DROP FORGED STEEL FITTINGS

SCREW END TYPE

For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SOCKET WELD TYPE

For schedules 40, 80 and 160 pipe — Sizes 1/8" to 6"

Round-the-clock operation of oil refineries, chemical plants, steam plants, etc., essential to the continuous flow of war products to the United Nations, is all in the day's work for these fittings. Today, as in peacetime, Vogt drop forged steel fittings make a major contribution to the efficient functioning of pipe lines in plants vital to the war effort.

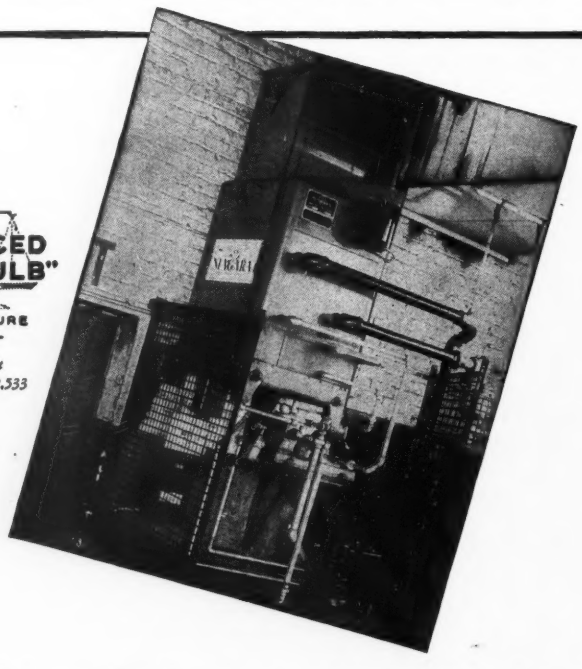
Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled matorials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy.

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE 10, KY.

BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

NEW AERO *After Cooler* GIVES DRY COMPRESSED AIR *and* saves cooling water



With "BALANCED WET BULB" TEMPERATURE CONTROL

U. S. Patent Re-issue No. 22,533

● Compressed air experts say that using more thoroughly dried air would save air tool users thousands of dollars in repairs and thousands of hours in lost time. In many industrial processes, drier air will prevent loss of valuable materials or rusting of delicate parts.

The NIAGARA Aero AFTER-COOLER offers a new method—the application of *evaporative* cooling—which makes possible lower air temperature and compressed air that is drier, safer to use for any purpose. It also provides closed circuit jacket water cooling with the Niagara "Balanced Wet Bulb" temperature control, preventing condensation and the washing of lubricating oil into the air lines.

In operation, it saves 95% of cooling water consumption, paying for itself in saving water cost. Write for Bulletin 98.

NIAGARA BLOWER COMPANY

Over 30 Years of Service in Industrial Air Engineering

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Field Engineering Offices in Principal Cities

INDUSTRIAL COOLING HEATING • DRYING

NIAGARA

HUMIDIFYING • AIR ENGINEERING EQUIPMENT

policy or products. Geo. B. Limbert & Co. will continue in business with general offices and warehouse at 570 Fulton St., Chicago 6, Ill., and fabrication shop at East Chicago, Ind. D. C. Showers will remain as president and general manager, E. L. Behrends as vice president, and Sodo Stritter as secretary and treasurer.

M. C. Pecsok became vice president of The Osborn Manufacturing Co., Cleveland, Ohio, May 1. He started to work for Osborn in 1912 as a cost clerk and has been there ever since, advancing through the organization to the position of sales manager of the company's brush division and now, to vice president.

W. A. Taylor & Co., has announced that Dr. G. E. Miller will become actively associated with the company, effective May 1. While Dr. Miller was one of the original founders of W. A. Taylor & Co., his duties at Edgewood Arsenal as technical adviser to the commanding general, left him little time to devote to the Company he helped form. Dr. Miller brings to the Taylor staff an unusual background in organic chemistry combined with a wide practical experience in its applications to industry and various Government agencies.

MANUFACTURERS' *Personals*

Recent changes in personnel and appointments which have been announced by the General Electric Co. include the following:

Dudley E. Chambers became executive engineer of the General Electric research laboratory. Mr. Chambers succeeds Dr. Laurence A. Hawkins, who has held the position since it was created in 1912 and is now retiring. He will remain as a consultant in the laboratory.

R. C. Sogge has been named assistant manager of General Electric's central station divisions. In addition to his new position, Mr. Sogge will continue as manager of the customer division, central station divisions.

J. J. Huether is now assistant manager of the industrial divisions, and W. A. Wirene manager of the industrial materials division, industrial divisions.

B. F. Ilsley has been appointed manager of General Electric's wire and cable division, central station divisions.

Charles F. Codrington has been appointed assistant to the manager and A. E. Caudle has been appointed sales manager of the Allis-Chalmers blower and compressor department. Both men assumed their duties May 1.

R. S. Zirbel has been advanced to the position of production manager for the Winslow Engineering Co. of Oakland, Calif. The promotion places Mr. Zirbel on the management staff of this manufacturer of oil conditioners and filter elements.

You can be Sure of Uniformity and Quality when you Specify Globe !

Extra care in production control assures uniformity and quality in all classes of Globe steel tubes. Unvarying quality is safeguarded and production methods and materials exactly controlled by one of the largest and complete chemical and physical laboratories of its kind, concentrating on tubing characteristics and problems.

You can be sure of uniformity and quality when you specify Globe tubes — pressure, mechanical, or stainless.

GLOBE STEEL TUBES CO., Milwaukee 4, Wis., U.S.A.

GLOBE STEEL TUBES

5019

- ★ Pressure Tubes
- ★ Condenser & Heat Exchanger Tubes
- ★ Seamless Stainless Steel Tubes

GLOBE TUBES

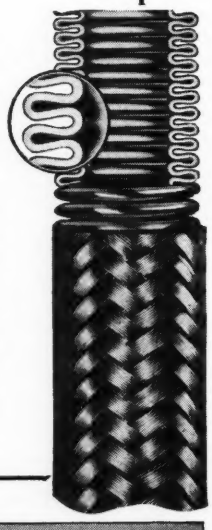
- ★ Mechanical Tubing
- ★ Gloweld Welded Stainless Steel Tubes
- ★ Globeiron High Purity Iron Seamless Tubes

REX-WELD

KING OF FLEXIBLE METAL HOSE!

There are reasons for leadership in every line. Better performance, finer quality, greater versatility and dependability . . . these and many more have given REX-WELD Flexible Metal Hose the high reputation it has today. A reputation that has earned the confidence of industry everywhere. Industrial men know the advantages of REX-WELD. For this rugged, seep-proof, airtight product has been outperforming ordinary connections on a wide variety of applications throughout industry.

Let "Flexon," the C.M.H. trademark character, show you in the sketches below some of REX-WELD'S outstanding features. Then ask us to give you the full story about REX-WELD and the other flexible metal hose products in our complete line.



REX-WELD . . . stands up under terrific flexation, vibration and strain. Its heavier, more uniform wall structure gives it greater strength, longer life.

REX-WELD . . . handles steam with utmost safety. It is seep-proof to gas, oil, water and searching fluids. It is highly rust-resistant and non-deteriorating.

REX-WELD . . . operates efficiently under pressures up to 5,000 p.s.i., temperatures to 1000° F. Greater strength and durability are the result of its 50-50 principle of corrugation . . . of an autogenous welding process that makes the weld stronger than the tube itself.

REX-WELD . . . is available in bronze and steel in sizes from 3/16-in. to 4-in. I.D. (incl.), with annular or helical corrugations, braided or unbraided, depending on requirements. REX-TITE heatproof mechanical couplings are easy to install and are reusable.

Flexible Metal Hose for Every Industrial Use

ARMY E NAVY

CHICAGO METAL HOSE CORPORATION

MAYWOOD, ILLINOIS

Plants: Maywood and Elgin, Ill.

C. G. Cox has been appointed to the executive staff of the Joshua Hendy Iron Works and will serve as administrative assistant to A. A. Browne, aiding in the formulation and execution of company sales and engineering policies. He will make his headquarters at Sunnyvale, California.

Lloyd B. Smith, son of the late L. R. Smith, for many years chairman of the board of the A. O. Smith Corp., was elected vice president and member of the board at a directors meeting May 1. Morris J. Vollmer, former assistant to the president, was named assistant secretary and assistant treasurer, and A. von Wening, vice-president and controller, was elected to the board.

Link-Belt Co. has announced the appointment of Clarence H. Schuettenberg as sales manager of its stoker division. Mr. Schuettenberg has been associated directly or indirectly with the stoker division since January, 1933. He will make his headquarters at the Link-Belt Caldwell plant, 2410 West 18th St., Chicago, where L-B stokers are built.

The Foxboro Co. announces that Clifford E. Alden has joined its staff and will make his headquarters at the home office, Foxboro, Mass. Mr. Alden, who has had wide experience in the field of municipal engineering, will specialize in the instrumentation of waterworks, sewage disposal plants, garbage incinerators and similar public works, and equipment and facilities of similar nature when operated as parts of industrial plants.

Briggs Clarifier Co., Washington, D. C., has announced the appointment of E. Digges La Touche to administer the field service engineering staff of the aviation division. Previous to the appointment by Briggs, Mr. Digges La Touche was executive assistant to the director general of the British Air Commission, which is charged with procurement, expediting and distribution of aircraft for Great Britain, having gone to that position from the staff of a New York investment firm.

Hewitt Rubber Corp., Buffalo, N. Y., recently announced that Joseph H. Hayden has been promoted to the position of vice president and William H. Watkins has been named controller and assistant treasurer.

C. E. Mason has been appointed technical director of the Bristol Co., Waterbury 91, Conn. Mr. Mason was graduated from Marietta College in 1917 and after service during World War I he practiced consulting engineering in Tulsa until 1925, which led to his specializing in automatic control problems. From 1925 until 1941 he was associated with the Foxboro Co. and for several years of that period he was director of control research. From 1940 until joining the Bristol Co. he was director of engineering of the Mason-Neilon Regulator Co. He has been actively associated with many technical groups studying the science of automatic control and is an active member of the committee on theory of the industrial instruments and regulator division of the ASME.

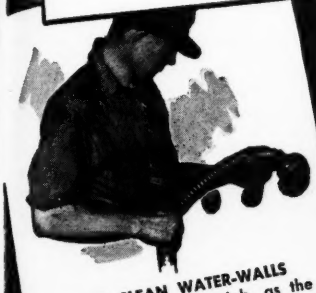
TRICKY TUBE CLEANING made easy-

FOR INSTANCE, SUPERHEATER TUBES of the return bend or hair-pin type. There is an Elliott cleaner for this, with a length of strong flexible shaft between the motor and the cutter head, which may be a threaded cone or a single-pin head. The motor does not have to go round the bend, which is cleaned halfway around from each straight portion of the tube.

Here are just a few examples which serve to show the versatility of Elliott tube cleaners, and the alertness and ingenuity of Elliott engineers in devising methods that take the toughness out of tube cleaning.

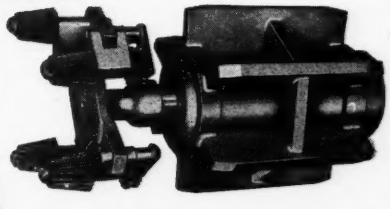
Have you a ticklish or unusual job that calls for this kind of experience? Take it up with Tube Cleaning Headquarters.

ELLIOTT COMPANY
Tube Cleaner Dept., **SPRINGFIELD, OHIO**
DISTRICT OFFICES IN PRINCIPAL CITIES



TO CLEAN WATER-WALLS Not really a tricky job, as the cleaning of side-, floor-, and water-wall tubes is common procedure using the agile and powerful Elliott 1300 Series motor with universal joint and proper Elliott cutter head. This equipment has flexibility to reach two tubes through one hand-hole opening.

BIFURCATED TUBES, TOO can be difficult — but not with this special equipment, which includes a guide to direct the cleaner into either tube. The guide threads into the tube, and can be turned and locked in the desired position. A flat on the end of the unit indicates the direction of the guide.



LARGE TUBE AND PIPES Not a usual job around a power plant, but sometimes necessary as in new installations, to remove sand, mill scale or weld sputter from fabricated pipe. The picture shows a 4¾ in. motor with special sleeve for entering 10 in. pipe. Cutter heads are available up to 20 inches.

ONE-MAN CLEANER CONTROL In all tube cleaning, but on tricky jobs especially, it is easy to see how vitally helpful is the Elliott foot-throttle valve. This enables the man guiding the cleaner also to start it, speed it up, throttle it down, or stop it, all instantaneously. Works like the accelerator on an auto—and certainly accelerates any job of tube cleaning.

All the above developments, and many more, described in the new Elliott Book on Tube Cleaning —on request.

Y-235

ELLIOTT Company

STEAM TURBINES • GENERATORS • MOTORS • CONDENSERS • FEEDWATER HEATERS AND DEAERATORS STEAM JET EJECTORS • CENTRIFUGAL BLOWERS TURBOCHARGERS FOR DIESEL ENGINES • TUBE CLEANERS • STRAINERS • DESUPERHEATERS • FILTERS

WHY "Megger"* Insulation Testers Have Not Been "Modernized"!

You may have wondered why we have not departed from the original operating principle of "Megger" insulation testing instruments—why we have not changed from hand operation to battery operation, or have not made use of electronic tubes or other devices. The reason is simple.

Ours is the business of building and supplying insulation testing instruments that can be depended upon to operate accurately and unfailingly—anytime and anywhere. To that end we have naturally considered, investigated and tested every element that might effect improvement. Years of research and the performance records of many thousands of "Megger" instruments have demonstrated that the classic simplicity of the "Megger" Insulation Tester with its hand-cranked generator and complete independence of any parts requiring replacement or adjustment is the best assurance of sustained, trouble-free, dependable service. "Megger" insulation testing instruments have been and will continue to be built to the high standards of fine instrument making practice.

For complete descriptions and applications of all types of "Megger" Insulation Testers write for Catalog 1685-PE.

**Trade Mark Reg. U. S. Pat. Off.*

JAMES G. BIDDLE CO. • **1211-13 ARCH STREET PHILADELPHIA 7, PA.**

Carnegie-Illinois Steel Corp., U. S. Steel subsidiary, has announced the appointment of Earl W. Pierce as chief metallurgist and Tom J. Peters as assistant to general superintendent at its South Chicago plant.

P. R. Mork has been elected executive vice president of Crane Co., Chicago, and J. A. Dwyer, vice president in charge of sales. As executive vice president, Mr. Mork will act for the president in his absence. The sales and branch house, the purchasing and the engineering and research divisions will report directly to him and he will co-operate in functional matters with the finance and manufacturing divisions. Mr. Dwyer succeeds Mr. Mork as vice president in charge of sales and branch houses.

Kiely & Mueller, Inc., North Bergen, N. J., announce the appointment of the Jno. D. Hiles Co., Plaza Building, Pittsburgh, Pa., as agent in that area for the K & M line of level and pressure controls and steam specialties.

The appointment of Howard W. Kelsey as sales promotion manager of the General Products Division, United States Rubber Co., has been announced. Mr. Kelsey has had more than 17 years experience in advertising and sales promotion work, including ten years as owner of his own agency and 18 months with Batten, Barton, Durstine and Osborn, Inc. Since June, 1944, he has been handling wire and cable promotion in the rubber company's Mechanical Goods Division.

Crane Co., Chicago, has announced the appointment of Lucien W. Moore as general manager of sales and branch houses, succeeding J. A. Dwyer, recently elected vice president in charge of sales and branch houses. F. J. Wilkey, district manager, Chicago, was appointed manager of the valve and fitting department, the position occupied by Mr. Moore until his recent assignment in France by the War Department.

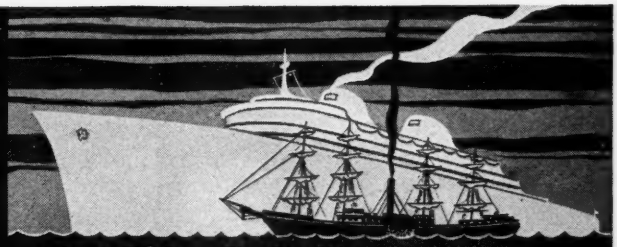
Mr. Moore had served the Crane subsidiary in France as manager of sales, and after his return to the United States in 1940 he was successively manager of pipe sales and general purchasing agent, before his appointment as manager of the valve and fitting department. He will assume his new duties on completion of his present special mission for the government.

Mr. Wilkey started with the company in the Cleveland Branch in 1929, where he filled various positions before being made manager in 1939. He was promoted to district manager at Cleveland in 1942, and transferred to the Chicago district in 1944.

The appointment of Lee C. Bennett to the position of central station manager of the Middle Atlantic District of Westinghouse Electric Corp. has been announced. Mr. Bennett will also retain the position of marine manager for the Middle Atlantic District, and his headquarters will continue to be in Philadelphia, Pa. He succeeds William P. Cochran in his new position. Mr. Cochran retired after 38 years with the company.

New SCREW PUMP

MAKES THICK FLUIDS FLOW SMOOTHER, FASTER

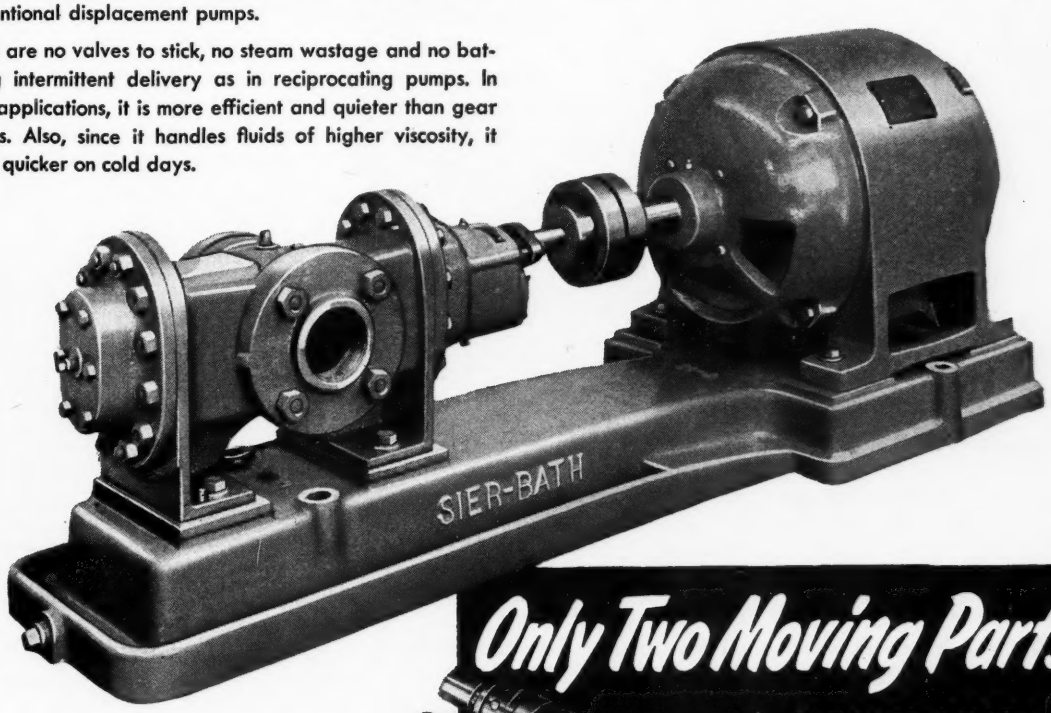


Take A Tip From The Big Ship:
"NOTHING BEATS THE THRUST OF THE SCREW"

This new Sier-Bath screw pump is as far ahead in pumping thick fluids as the twin screw propeller is ahead of the old style paddlewheel. For it applies the screw's tremendous torque to heavy fluids and thus overcomes the difficulties of conventional displacement pumps.

There are no valves to stick, no steam wastage and no battering intermittent delivery as in reciprocating pumps. In most applications, it is more efficient and quieter than gear pumps. Also, since it handles fluids of higher viscosity, it starts quicker on cold days.

When used on fuel oil lines, its pulseless discharge prevents "puffy" firing and improves boiler efficiency. Furnished in both external and internal gear types. Write for Bulletin.



PUMPS—asphalt—Bunker C Fuel Oil—greases—molasses—soaps—syrups—cellophanes—acetates.

☆ *MANUFACTURING QUALITY PRODUCTS SINCE 1904* ☆

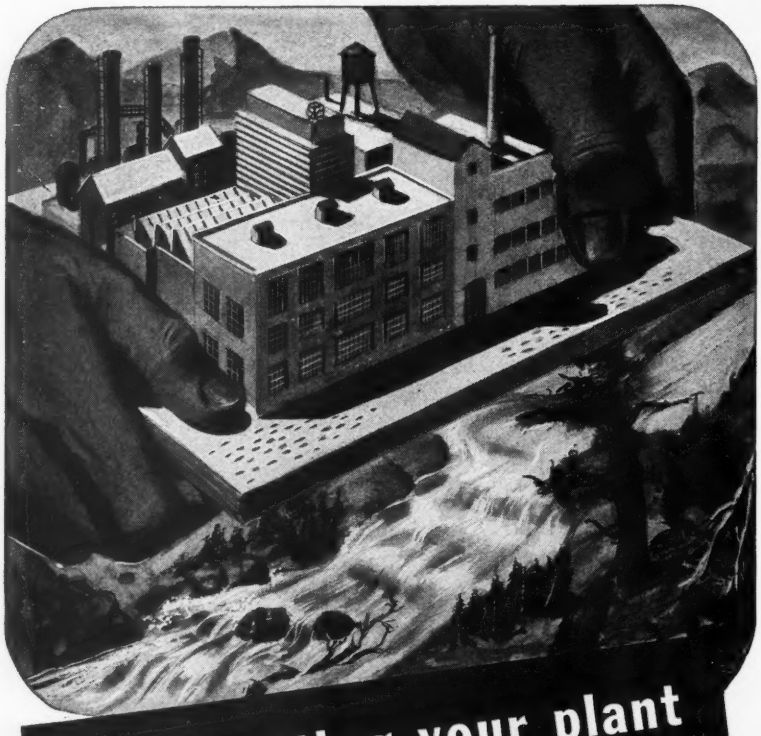
Sier-Bath Gear Co.

9256 Hudson Blvd.
NORTH BERGEN, N. J.

Only Two Moving Parts

MEANS LOW MAINTENANCE

Two screws are only moving parts. End to center fluid movement of horizontally mounted units eliminates thrust bearings. Self-centering timing gears prevent sidewear resulting from screw contact. Packing can be added while pump is running.



Like putting your plant BESIDE A MOUNTAIN STREAM

Chlorination of process and cooling water is like having a mountain stream at your doorstep. No longer need raw water bacterial quality be a major factor in selecting a site for a new manufacturing plant . . . nor need a requirement for water of higher bacterial quality necessitate a change from your present location.

Wallace & Tiernan chlorination can eliminate the effect of pollution, making any raw water supply bacterially suitable for industrial cooling water or for process purposes, at a cost often less than the resulting yearly savings in fuel and manpower.

From their wide experience in solving water treatment problems in scores of different industries, Wallace & Tiernan Engineers will recommend the method best adapted to the individual needs of your plant.

CD-14

WALLACE & TIERNAN PRODUCTS, INC.

Manufacturers of Chlorine and Ammonia Control Apparatus

Belleville 9, New Jersey — Represented in Principal Cities

NEWS *from* THE FIELD

Western States Council

NATIONAL ATTENTION will be directed to the light metals industry of the West—its spectacular wartime development and its post-war prospects—when the Western States Council holds a two-day conference on this subject in Seattle June 21 and 22.

The objective of the conference is post-war maintenance and operation of an integrated light metals industry in the eleven Western States under private ownership.

The Western States Council was organized in October, 1944, to coordinate western action on matter of regional concern. It is made up of executives of chambers of commerce in all eleven western states. Christy Thomas, executive vice president of the Seattle Chamber of Commerce is president of the Council.

First project undertaken by the organization was an intensive study of the West's steel industry and its post-war potentialities. Following a two-day conference held at Salt Lake City in February, a comprehensive program was set in motion to retain this important industry, which has expanded tremendously in wartime, as a permanent and integrated factor in western economy. Private ownership and operation is the goal.

The urgent need for light metal in the war production program brought great expansion to the West's aluminum and magnesium industries. The most spectacular development of aluminum reduction has taken place in the Pacific Northwest, where new war plants have been built to take advantage of the abundant, low-cost electrical energy.

Every phase of the problem will be analyzed at the Seattle meeting. Both the bright and dark aspects of the picture will be discussed in detail.

A.S.H.V.E. Laboratory Studies

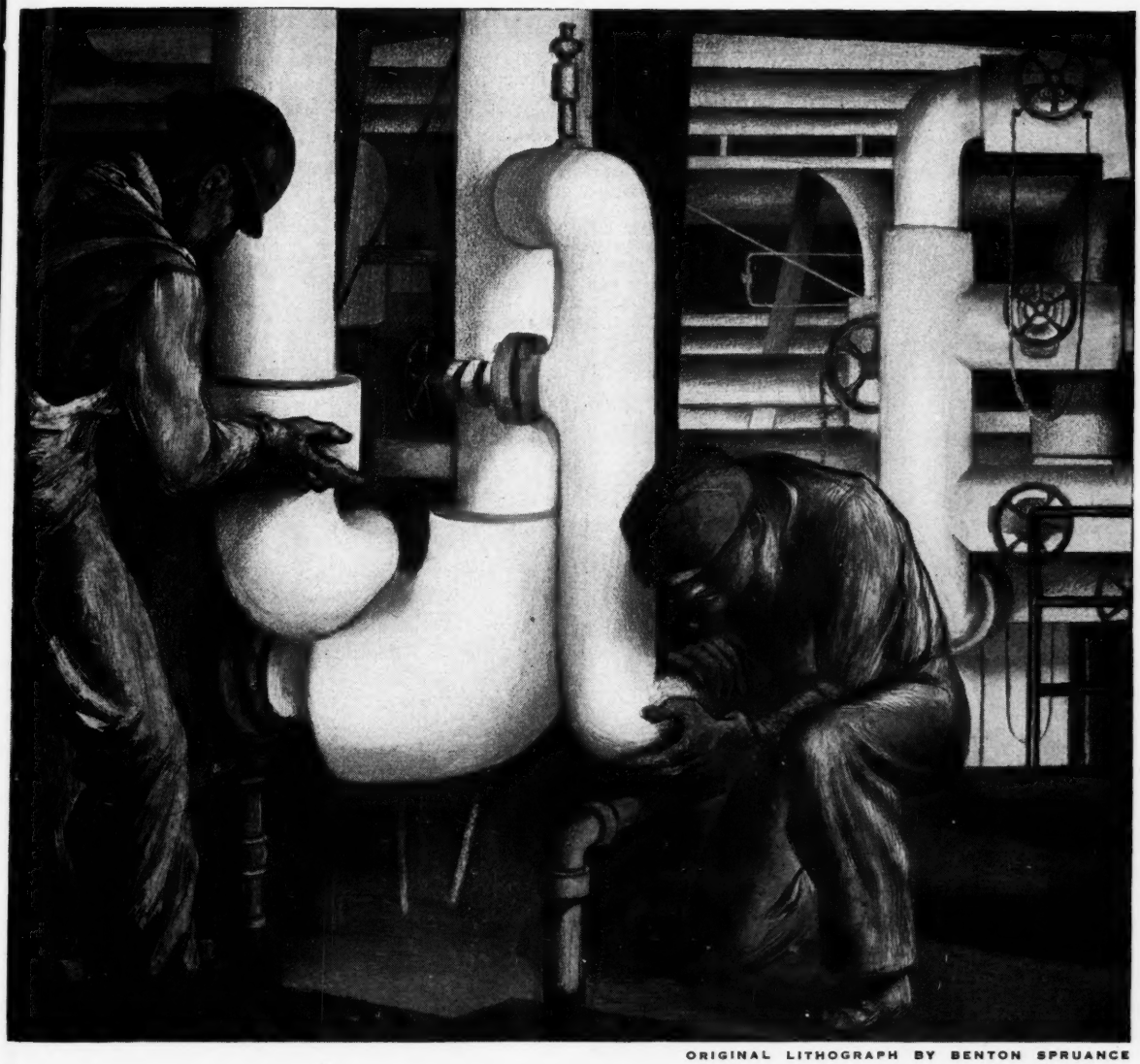
ONE OF THE MAJOR studies at the Research Laboratory of the American Society of Heating & Ventilating Engineers, Cleveland, Ohio, will be the subject of air duct friction under the direction of the Technical Advisory Committee on Air Distribution and Air Friction.

A report on the following aspects of the subject of air duct friction prepared by Professor Wright for the Committee on Research, was considered at a recent meeting.

(a) A comparison of basic source data.

(b) A comparison of the present friction chart in the Guide with similar charts or tables in use by various organizations or recommended in handbooks and textbooks.

In presenting his report, Professor



ORIGINAL LITHOGRAPH BY BENTON SPRUANCE

Fighting Btu's

THE Btu's produced in boilers and distributed through steam lines are not only fighting the wartime battle of production. They also fight, year in and year out, to escape in the form of heat losses. Industry's effort to prevent the waste of heat is never-ending.

The battle against heat loss is as broad as all industry. With every boiler, steam line, fitting and heated surface a potential avenue of waste, they should be amply protected with a highly efficient thermal insulation such as Ehret's 85% Magnesia or Enduro. These time-defying insulating materials have been conserving heat in countless installations for nearly half a century. Those who specify or use these materials like them because they are dependable, economical and trouble-free.

THE EHRET HEAT INSULATION HANDBOOK *contains a wealth of information on 85% Magnesia, Enduro high temperature and many other insulations — with selection and application data for boilers, piping and equipment. Fully illustrated, it includes heat loss and efficiency tables, specifications and recommendations for every temperature condition. A copy will be sent at your request.*

EHRET

MAGNESIA MANUFACTURING CO.

VALLEY FORGE • PENNSYLVANIA

Wright stated, "Authorities in the field of fluid mechanics are in essential agreement as to the general equations governing the friction of fluid flowing in closed round pipes. These relations have been employed by Rouse and by Moody in preparing charts from which the friction coefficient can be determined. It has been definitely established that these charts are valid for a large number of fluids, air among them. Since any practicable set-up for testing the friction of ventilating ducts is limited as to sizes of ducts which can be tested, and velocities which can be reached, such tests as were made in the past have been generally restricted to conditions in the lower portion of the friction chart. This limited range of results leads to an equation which can be greatly in error if extrapolated sufficiently to include the range of the usual friction chart." In view of the general acceptance of the basic functions, Prof. Wright suggested that it would be a better procedure to use the results of tests on ducts to evaluate the one unknown in the equation, i.e. the roughness parameter, and to make up the proposed friction chart on that basis.

It was pointed out that the friction charts now in general use tend:

(1) To give friction values too low in the upper range if satisfactory in the low range, or too high in the middle if satisfactory at top and bottom.

(2) To over-emphasize the effect of change of diameter in the low velocity range.

(3) To under-emphasize the effect of change of diameter in the high velocity range.

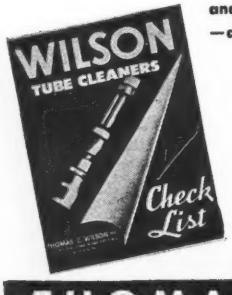
YOU CAN BUILD YOUR OWN TUBE CLEANERS

Have you ever wished that you had the facilities available to build your own tube-cleaners for special or unusual jobs? The chances are you can do just this—and do it easily too.

You can do it by selecting one of the numerous motors and one of the many cutter-heads from the large assortment of Wilson Tube Cleaners and parts that are available.

A copy of the Wilson Tube Cleaners Check-List will help you make this selection, and thus help solve your tube-cleaning problems. It shows various Wilson Tube Cleaners for practically every type of deposit in straight or curved tubes—tube cleaners that get the job done faster!

The Check-List also contains valuable information on operation and maintenance of tube cleaners. Your copy will be sent on request—and without obligation.



wilson

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

Asbestos Textile Institute Formed

A NUMBER OF ASBESTOS textile manufacturers have formed the Asbestos Textile Institute, with offices at 12 S. 12th Street, Philadelphia 7, Pa. It is a voluntary, non-profit, unincorporated organization whose function is to render service to manufacturers, to the trade, and to users of asbestos textiles. Membership in the Institute is open to all individuals, corporations or others located in the U. S. who manufacture textiles from raw asbestos fibres.

With the formation of the Institute, the following companies became members: Asbestos Textile Co., J. Franklin Burke & Co., Carolina Asbestos Co., Garlock Packing Co., Johns-Manville Corp., Keasbey & Mattison Co., Philadelphia Asbestos Co., Raybestos-Manhattan, Inc., Southern Asbestos Co., and Union Asbestos & Rubber Co.

Among the various activities contemplated by the Asbestos Textile Institute are the establishment of uniformly high standards of quality, research to develop new uses and new markets for asbestos textiles, and the preparation and distribution of technical and general information that will be of interest and value to engineers, designers, distributors, manufacturers and the general public.

The officers elected to head this new Institute are: C. H. Carlough of Carolina Asbestos Co., president; George Marshall, Jr. of Raybestos-Manhattan, Inc., vice president; William C. Scott of Keasbey-Mattison Co., treasurer and Harris D. McKinney, the Institute manager and secretary.

The Board of Governors is composed of: C. H. Carlough, Chairman; G. S. Fabel of Southern Asbestos Co.; George Marshall, Jr.; W. C. Scott; E. R. Teubner, Jr. of Philadelphia Asbestos Co.; and F. J. Waken of Johns-Manville Corp.

Chisholm Approves Heating Plan

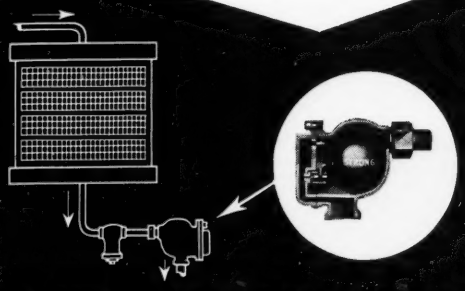
THE CHISHOLM CITY, MINN., Council has recently passed or ordinance granting a franchise for furnishing central steam heat and electric power to the entire city, from a co-operatively-owned plant. The plan was considered doubly attractive because it provides an ideal civic improvement project for post-war construction and employment.

The franchise, awarded to John J. Dwyer of Duluth, authorizes the construction of an adequate steam and electric generating plant with the necessary underground heat distribution lines and electrical circuits, just as soon as war production schedules permit release of materials.

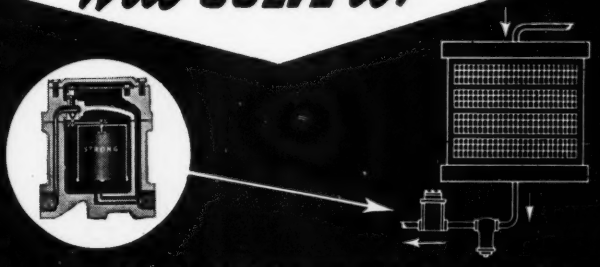
Steam service will be made available to every residential, commercial and industrial building, where it can be adapted to existing warm-air, hot-water or steam heating systems. It

ARE UNIT HEATERS YOUR *Problem?*

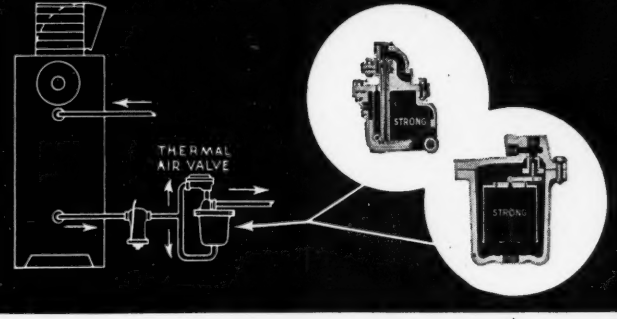
ONE OF THESE STRONG HOOK-UPS *will SOLVE it!*



Ball float and thermostatic trap—this heavy-duty trap is fitted with two valves, both of which are open during peak starting loads when large amounts of air and cold condensate are entering trap. Main valve is float controlled. Thermal unit is bi-metal, positive in operation and closing tight when line reaches steam temperature.



Inverted bucket and thermostatic trap—a two-in-one trap (blast) combining economies of inverted bucket design with thermal trap air capacity. Inverted bucket operates to discharge condensate intermittently through main valve. Separate by-pass allows free passage of air and water through thermal valve until steam temperature is reached. Valve then closes.



Open or inverted bucket with separate thermal by-pass—recommended for larger installations requiring fast heating. Separate thermal valve is piped as a by-pass around either the open or inverted bucket trap. These traps also preferred for heaters operating at pressures over 30 lbs. because of intermittent operation and minimum maintenance.

BRING YOUR DRAINAGE PROBLEMS TO US

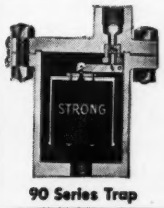
Long, specialized experience, plus the fact that Strong makes the widest line of drainage equipment combine to give you the most satisfactory installation on any type of service.

The Strong line includes open and inverted bucket traps, float, float-and-thermostatic (blast), etc.—cast and semi-steel, forged and welded construction.

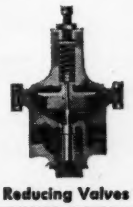
We welcome the opportunity to help you on any drainage problem. Write Strong, Carlisle & Hammond Company, Cleveland 13, Ohio.

STRONG, CARLISLE & HAMMOND CO.
Cleveland 13, Ohio

OTHER STRONG STEAM SPECIALTIES



90 Series Trap


Reducing Valves

Thermal Air Valve

was brought out at Council meetings that this would completely eliminate the need for individual furnace stoking and ash handling, and would abate a smoke nuisance, assuring a cleaner, more healthful community. Preliminary estimates indicate that the overall fuel consumption will be reduced approximately 25 per cent. Another benefit considered was the utilization of extra basement space upon removal of individual furnaces. It was also pointed out that new homes could be spared the expense of basement excavation and construction.

The city is now served with light and power from an extensive power transmission system. Under the new plan, the citizens of Chisholm will purchase heat along with electricity, gas and water, from a central source.

American Mobile Power Plants

FIRST ACCOUNTS OF how American-built mobile electric power trains helped the Red Army smash into Berlin are being discussed by engineers and production experts of the General Electric Co. and the American Car & Foundry Co. who supplied 63 such plants with a total generating capacity of 143,000 kw to the USSR.

"They invariably follow in the wake of the advancing Red Army," an Embassy of the Union of Soviet Socialistic Republics bulletin states. "Since the first days of the offensive, mobile stations have traveled to the front with the armored trains and have rendered invaluable service to tank and truck repair shops, supplying them with power."

The efficient pattern of how the Russians relied on the mobile power plants to rehabilitate cities as quickly as they were retaken from the nazis and thereby strengthen further advances is revealed by the bulletin.

"The stations played a vital part in restoring Stalingrad, the Donbas, the Crimea, Zaporozhye, Krivoi, Rog, Gomel, Minsk, and other cities," it relates. "The People's Commissariat of Power has sent 30 new mobile power stations to the liberated districts."

Forty of the 63 turbine-electric mobile power plants supplied by General Electric generate 3000 kw of electric power each. The other 23 are 1000 kw units.

The 3000-kw plant is described as a train of nine specially built railroad cars which can be handled at fast-freight speed and put into service within about eight hours after arrival at a power needy area. Two locomotive boiler cars, two tenders, a turbine-generator car, a switchgear car, and three cooling tower cars compose each of the plants.

First of the 3000 kw mobile power plants were delivered to the Soviet government June 1, 1944 at Berwick, Pa., at which point the USSR took the responsibility for shipment abroad.

Public Service Makes Promotions

ANNOUNCEMENT IS MADE by vice president Jacob T. Barron of the following promotions in the electric departmnet of Public Service Electric & Gas Co., Newark, N. J.

Hollis K. Sels to be transmission and distribution engineer, succeeding Rollin, who died recently. Theodore Seely to be transmission and substation engineer. Oscar Bauhan to be assistant transmission and substation engineer.

Mr. Sels started with Public Service in 1923 as engineer in the office of the transmission engineer and was promoted to assistant transmission and substation engineer in 1928. He has been transmission and substation engineer since 1938.

Mr. Seely entered the company cadet engineers' course in 1923. In 1926 he was assigned to the electric distribution department, central division. After one year in the Perth Amboy District, Mr. Seely was transferred to the Elizabeth District. In 1930 he entered the office of the distribution engineer, as assistant engineer. He was advanced to distribution planning engineer in 1937, and to assistant distribution engineer in 1940. In 1943 Mr. Seely was transferred to the transmission and substation engineer's office as assistant transmission and substation engineer.

Mr. Bauhan started with the Company as district substation operator in New Brunswick District in 1923. He was transferred to the general office in 1924, and from then, until 1942, served as engineer and instal-

Courtesy General Aniline & Film Corp.

LADISH
CONTROLLED QUALITY

FITTINGS

There is no Substitute for Quality Control

TO MARK PROGRESS

ARMY E NAVY

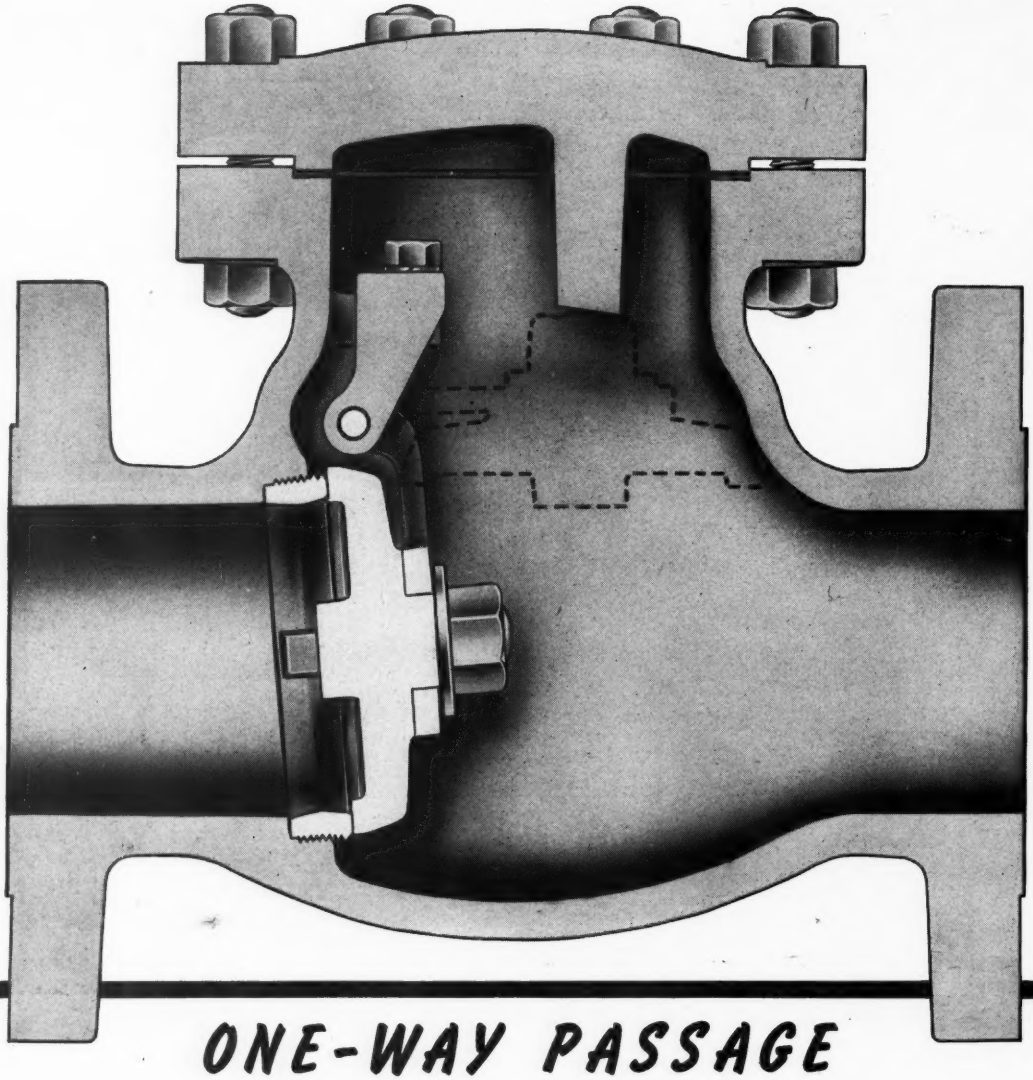
FITTINGS DIVISION

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN

MILWAUKEE SUBURB

District Offices: NEW YORK CITY • PITTSBURGH • CLEVELAND • ST. LOUIS • HOUSTON • LOS ANGELES



ONE-WAY PASSAGE

THERE'S no round-trip ticket . . . *but only one-way passage* . . . for fluids when you use the OIC Cast Steel Swing Check Valve. When this valve **seats,** it positively prohibits back-flow.

Furthermore, there's always a free flow in the right direction. The disc swings clear above the waterway, leaving it in wide-open position.

The entire disc assembly is removable through the cap opening. Its suspension from two integral brackets inside the valve body eliminates the necessity for drilled holes in the body casting.

OIC Cast Steel Valves . . . Checks . . . Globes . . . Angles and Gates . . . are available in the 150 and 300-pound pressure classes, with screwed, flanged or butt welding joints. They embody the same qualities of workmanship and materials that have made OIC Bronze and Iron Valves so outstanding for 62 years.

There is an OIC Distributor near you, ready to demonstrate to you the many superior features of OIC Cast Steel Valves. Call him . . . or write to us for details.

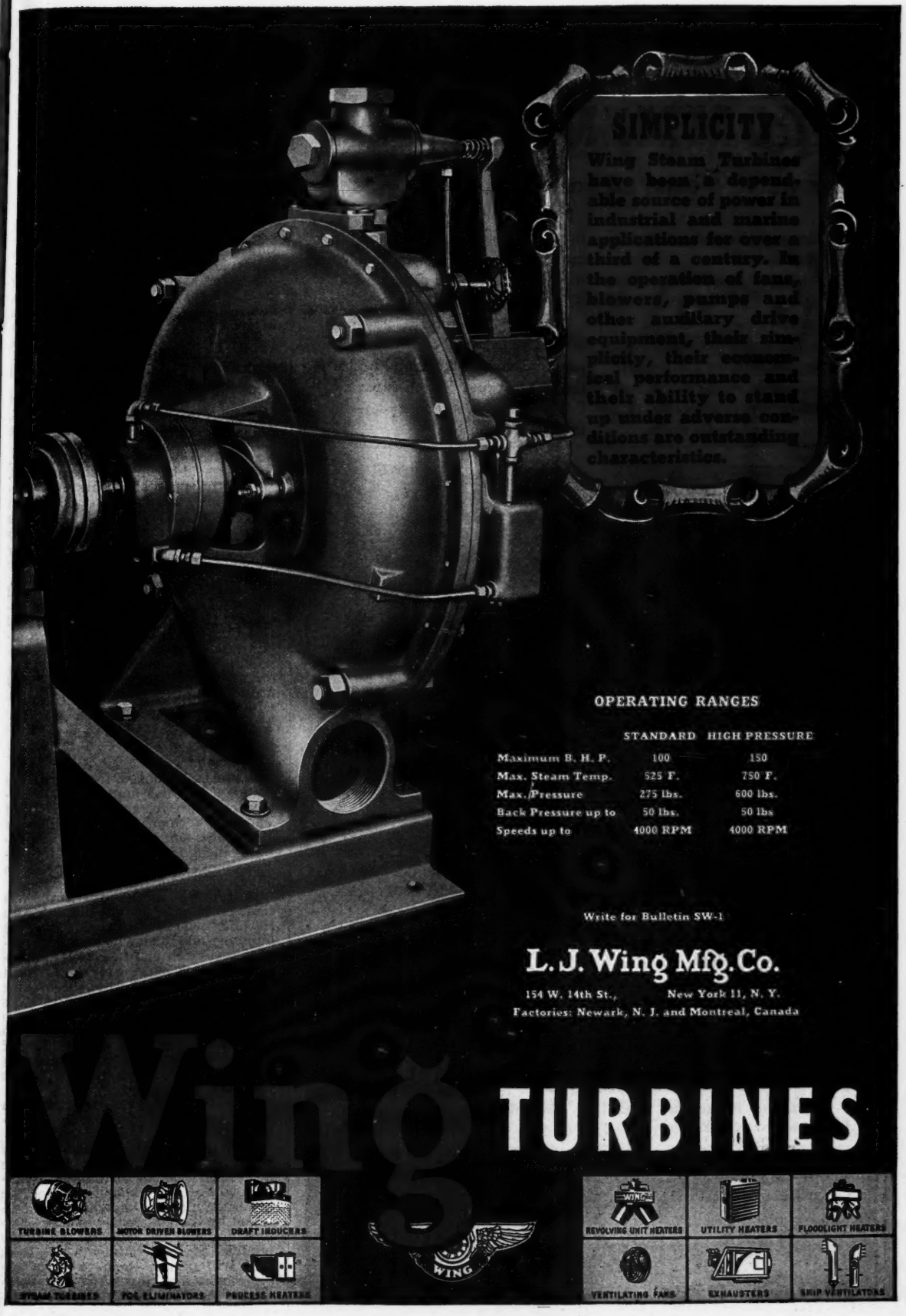
ARMY E NAVY

OIC

THE OHIO INJECTOR COMPANY

WADSWORTH, OHIO

Quality Leaders in Valve Manufacture Since 1883



SIMPLICITY

Wing Steam Turbines have been a dependable source of power in industrial and marine applications for over a third of a century. In the operation of fans, blowers, pumps and other auxiliary drive equipment, their simplicity, their economical performance and their ability to stand up under adverse conditions are outstanding characteristics.

OPERATING RANGES

	STANDARD	HIGH PRESSURE
Maximum B. H. P.	100	150
Max. Steam Temp.	525 F.	750 F.
Max. Pressure	275 lbs.	600 lbs.
Back Pressure up to	50 lbs.	50 lbs
Speeds up to	4000 RPM	4000 RPM

Write for Bulletin SW-1

L. J. Wing Mfg. Co.

154 W. 14th St., New York 11, N. Y.
Factories: Newark, N. J. and Montreal, Canada

Wing TURBINES

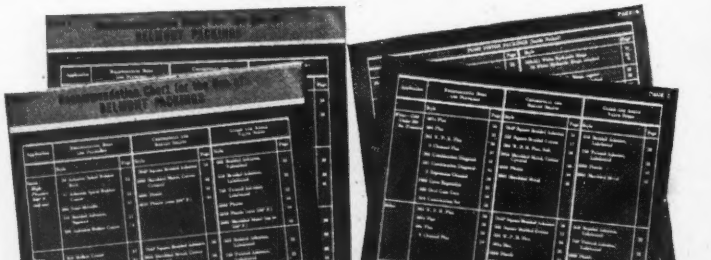
PACKING RECOMMENDATIONS

for water, steam, oil and gasoline service

Next time you give stuffing boxes the regular, frequent check they need under today's operating conditions, have near at hand Belmont's PACKING RECOMMENDATION CHARTS.

They will enable you to select from the complete Belmont line the packing that is right for the job. There is hardly a conceivable service for which Belmont cannot provide the packing that will keep equipment operating at maximum capacity — without leaks that waste power, cut down production and cause expensive replacements.

Belmont Distributors are located in every large industrial center, ready to serve you promptly from local stocks. Get the PACKING RECOMMENDATION CHARTS from the one nearest you — or send the coupon to us.



Have us send you the handy PACKING RECOMMENDATION CHARTS, plus information on the complete line of Belmont Packings

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

on the blue-and-orange box

THE BELMONT PACKING AND RUBBER COMPANY
Butler & Sepviva Streets, Philadelphia 37, Pa.

Gentlemen: Please send PACKING RECOMMENDATION CHARTS for the services checked:

☐ Steam ... ☐ Hot Water ... ☐ Cold Water ... ☐ Brine ... ☐ Ammonia ...
☐ Acids & Caustics ... ☐ Air ... ☐ Gas ... ☐ Oil ... ☐ Gasoline ...
☐ Asphaltic & Tar Products ...

Name .....
Company .....
Address .....

lation engineer for the transmission and substation engineer on the design and construction of substations and switching stations. In 1942, he was assigned the job of coordinating the engineering of Public Service facilities with the equipment of the various war industries.

G. H. Blake Heads Public Service Corp.

THE RETIREMENT OF Edmund W. Wakelee as president of Public Service Corp. of New Jersey and subsidiary companies was announced by Chairman of the Board Thomas N. McCarter at the annual meeting of stockholders of the Corporation in Newark. Mr. Wakelee has not been in good health for the past year or so and is now critically ill at his home in Demarest, N. J. George H. Blake was elected to succeed Edmund W. Wakelee, president since 1939.

Thomas N. McCarter was reelected chairman of the board and Percy S. Young, chairman of the executive committee. Thomas N. McCarter, Jr., was elected executive vice president, the post held by Mr. Blake since 1943.

For the past six years Mr. McCarter has been vice president in charge of the company's Southern Division. All other executive officers of the Corporation and subsidiary companies were reelected or reappointed.

Frederick A. Lydecker was named vice president in charge of gas operation, Public Service Electric and Gas Co., and a director of the Corporation's subsidiary companies succeeding John A. Clark who retires. Mr. Lydecker has been assistant vice president in charge of gas operation.

Van Pelt Joins Battelle

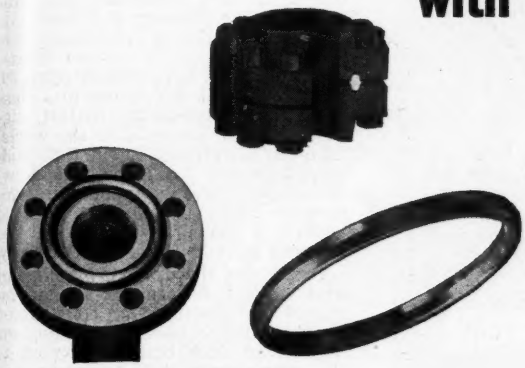
BATTELLE MEMORIAL INSTITUTE, Columbus, Ohio, has announced the appointment to its staff of J. Robert Van Pelt, formerly technical director of the Museum of Science and Industry, Chicago, who will assume responsibility for an expanded program of research education.

Battelle Memorial Institute was founded in 1929 by the late Gordon Battelle, whose will provided for the building and endowment of a nonprofit research institute "for the purpose of education, the encouragement of creative research, and the making of discoveries and inventions." Its program of basic research serves two interrelated ends: It contributes to the advanced professional training of your scientist and technologist. It adds to the world's store of basic scientific knowledge.

This two-fold program has been given the name, "Research Education."

With the impending return of many young men and women from the armed services to civilian life, Battelle will greatly expand the program of research education which was curtailed by the exigencies of war. Fellowships will be available to highly qualified graduate students on a basis that will permit them to learn the philosophy and to practice the methods of modern highly-organized re-

RELIEF from pipe line shut-downs with GRUV-SEAL "Forged-Iron" Ring Gaskets



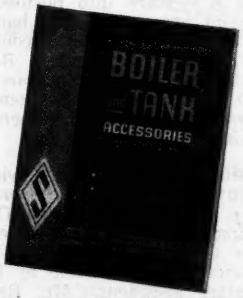
Pressure-proof flange connections—tight as a weld—on high or low pressure pipe lines! Gruv-Seal "Forged-Iron" Ring Gaskets are machined to a fine, smooth finish, stay put and protect you against pipe line shut-downs.

With Gruv-Seal "Forged-Iron" Ring Gaskets, wrench pressure molds a tight seal that stays tight always—reduces power losses and other pipe line trouble. These gaskets should be used at all flange connections, valve bonnet joints, and at joints where ready disassembly is a necessary requirement.

Gruv-Seal "Forged-Iron" Ring Gaskets are manufactured by a special forging method which eliminates metal porosity and interlocks the metal fibre lines into a dense, tough structure such as is obtained by no other fabricating process. Gruv-Seal "Forged-Iron" Ring Gaskets are exact in every detail; true in diameter, circumference, and in thickness; perfectly proportioned and machined to a fine, smooth finish. The metal from which these are forged possesses corrosion-resisting properties beyond those of ordinary steels.

Gruv-Seal "Forged-Iron" Ring Gaskets are forged in a wide range of sizes, including all standard A. P. I. sizes. New sizes are constantly being worked out as requirements occur. Write for special bulletin on Gruv-Seal "Forged-Iron" Ring Gaskets.

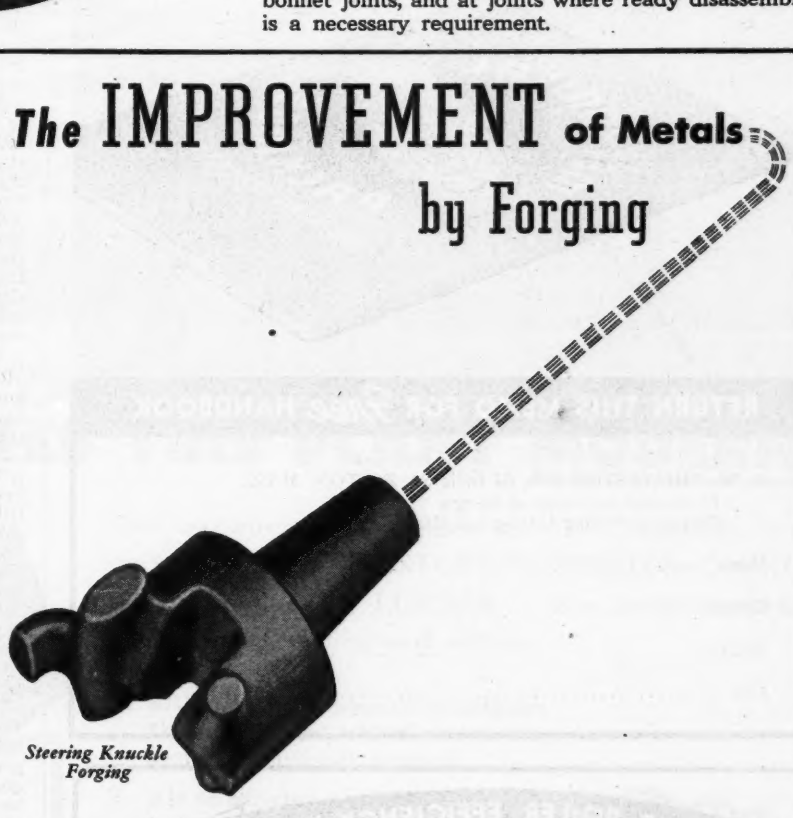
These gaskets are one item of the complete line of Diamond "S" Forged Boiler and Tank Accessories which includes manhole cover assemblies, handhole cover assemblies, welding street ells, welding necks, all of which are forged to close tolerances from suitable metals, and fully meet and exceed A. S. M. E. requirements for steel use in pressure vessel parts.



Catalog No. 10 illustrates, describes, and lists a complete line of forged steel boiler and tank accessories and contains technical data and general information about the application of such products.

THE STEEL IMPROVEMENT & FORGE CO.
986 East 64th Street • Cleveland, Ohio

The IMPROVEMENT of Metals by Forging



Steering Knuckle Forging

The IMPROVEMENT of Metals by Forging develops high tensile and impact strength, toughness and fatigue resistance in simple, as well as highly stressed parts, and assures dependable performance of vital equipment in the production, refining and marketing of petroleum products. Buy equipment fortified by forgings for unpredictable emergencies.

DROP FORGINGS

THE STEEL IMPROVEMENT & FORGE CO.
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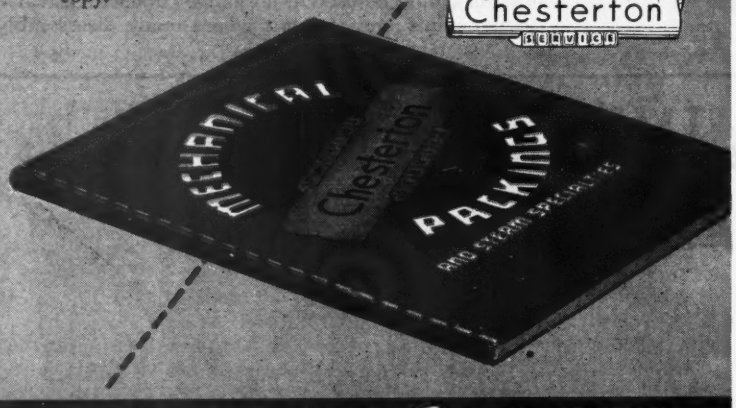
Yours WITH OUR COMPLIMENTS..

This new, compact 72-page CHESTERTON Mechanical Packing Catalog and Handbook describes a complete line of seals for hot and cold water, low and high pressure steam, hot oils, chemicals, acids, solvents, etc. . . . Also bristles with easy-to-use specification charts, conversion tables for cutting ring packings and other engineering data. A valuable addition to the file of every operating and maintenance engineer. Use handy memo below to get your free copy.



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Please send me a copy of the new 72-page Chesterton Packing Catalog and Handbook

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STEP UP BOILER EFFICIENCY WITH A

VIBRATAP

It's the fast, thorough way to remove fuel-wasting soot and scale from boiler tubes. Comes in fire-tube and water-tube models.

Write today for latest descriptive Bulletin V-16. It shows how to step up boiler efficiency through cleaner tubes.

BRUNT EQUIPMENT CO. 59 SOUTH DIVISION STREET BUFFALO 3, NEW YORK

search, while also deriving the usual benefits of graduate work in their own university.

Babcock & Wilcox's 1800th Marine Boiler

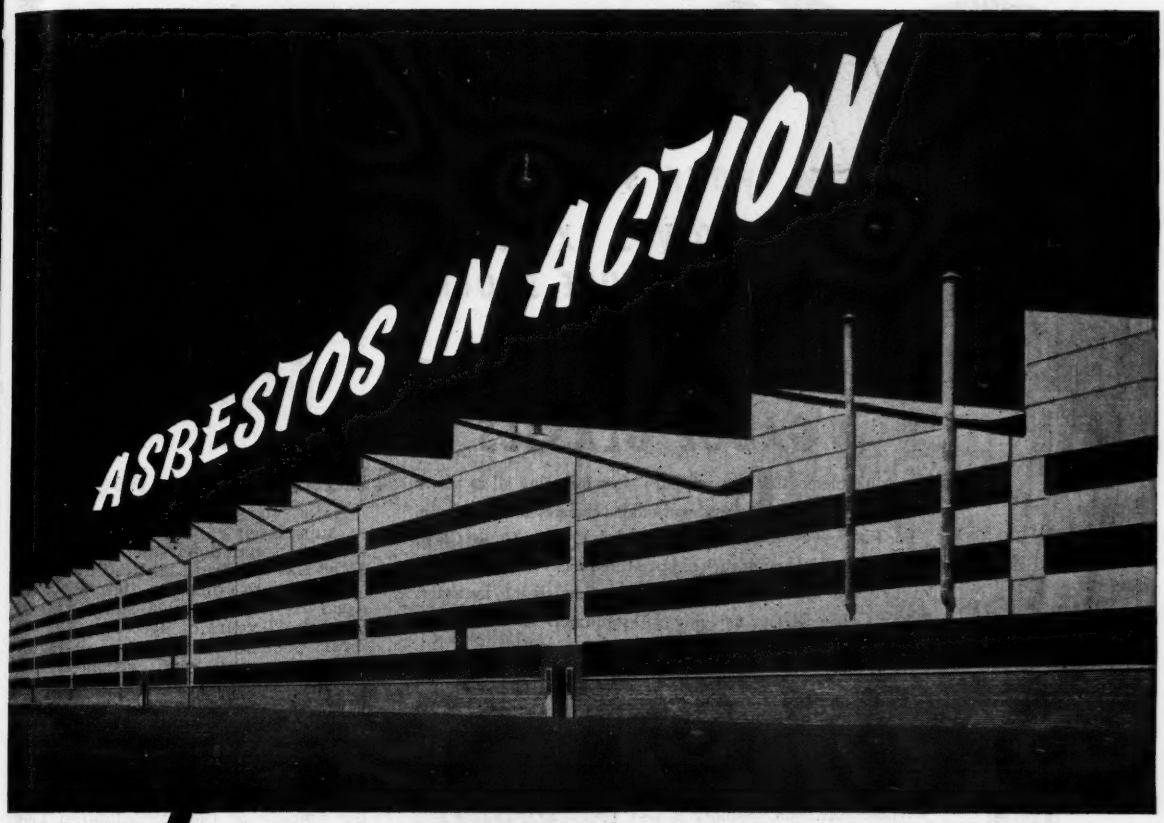
THE 1800TH MARINE BOILER built for the U. S. Navy combatant ship program by The Babcock & Wilcox Co., has been installed in the aircraft carrier U.S.S. Franklin Delano Roosevelt which was launched on April 29. The Roosevelt is the second of a class of carriers rated as the fastest, biggest and most powerful in the world. Like her sister ship, the U.S.S. Midway, launched last March in Newport News, she is equipped with two-furnace single uptake express type boilers, a design developed by The Babcock & Wilcox Co. for the Navy.

Officials of the Company point out that while the Roosevelt boilers included the 1800th to be constructed on their Navy boiler schedule, the number of such boilers supplied to the combatant ship program has probably reached over the 2300 mark at the present time. The boilers for the Franklin Delano Roosevelt were installed more than a year ago, due to the fact that boilers in Navy ships are placed in position in the earliest stages of construction. Since these boilers were installed the Company has supplied boilers for more than 500 additional Navy vessels, including combat ships and auxiliaries. A third carrier of the Midway and Roosevelt class now under construction will carry the same type of boiler developed by the Company for the first two vessels.

The U.S.S. Roosevelt has an overall length of about 1000 ft, and she will carry approximately 3000 men and more than 80 planes of a new type.

The Bureau of Economic and Business Research of the University of Illinois has just announced the publication of a 44-page booklet entitled "Should I Start My Own Business?" The booklet, prepared by P. D. Converse, professor of marketing, carries chapters on Why Start a Business? Qualifications for Operating a Business Successfully, and Finding and Evaluating Opportunities. It is designed especially for persons who are considering a venture into business. Veterans who are considering bank loans for business ventures could profit by reading the booklet. Requests for this free publication should be sent to the Bureau of Economic and Business Research, 205 Commerce Building, Urbana, Illinois.

R. G. Rincliffe was elected vice president in charge of electric operations of the Philadelphia Electric Co. at a meeting of the Board of Directors of the Company held April 24. The announcement was made by H. P. Liversidge, president. Mr. Rincliffe entered the utility business as an engineering assistant at Chester, Pa., in 1923. Following a succession of various assignments, he was named superintendent of gas production in 1927. Four years later he was made superintendent of gas manufacturing for the entire company. In 1938, he was named purchasing agent, continu-



"Century" Asbestos Corrugated
MAKES THIS PLANT MODERN

This vast aircraft plant chose the *right materials.* It is built with K&M "CENTURY" ASBESTOS CORRUGATED and FLAT LUMBER . . . the perfect material for industrial roofing and siding.

Nature made Asbestos

"Century" Asbestos Corrugated and Flat Lumber is a typical example of how Keasbey & Mattison has made Asbestos serve modern construction. Here are six good reasons why it pays to use this material for building new plants, renovating old ones.

1. **It is *tough* . . . a combination of asbestos fibre and portland cement, produced by tremendous hydraulic pressure.**
2. **It is an *attractive* material . . . needs no surface finish or applied decoration.**
3. **It is an amazingly adaptable material. Comes in 19 different sizes.**
4. **It is economical because it is maintenance free.**
5. **It is completely fire resistant.**
6. **Installation time is reduced to a minimum.**

Thousands of plants, throughout the country, have found satisfaction with K&M "Century" Asbestos Corrugated and Flat Lumber. You'll find satisfaction too. You'll save time and money, and avoid risk, when you build the modern, "Century" way. Bring your problem to your authorized Keasbey & Mattison Distributor. He is well supplied to meet your material and erection requirements for "Century" Asbestos Corrugated and Flat Lumber.

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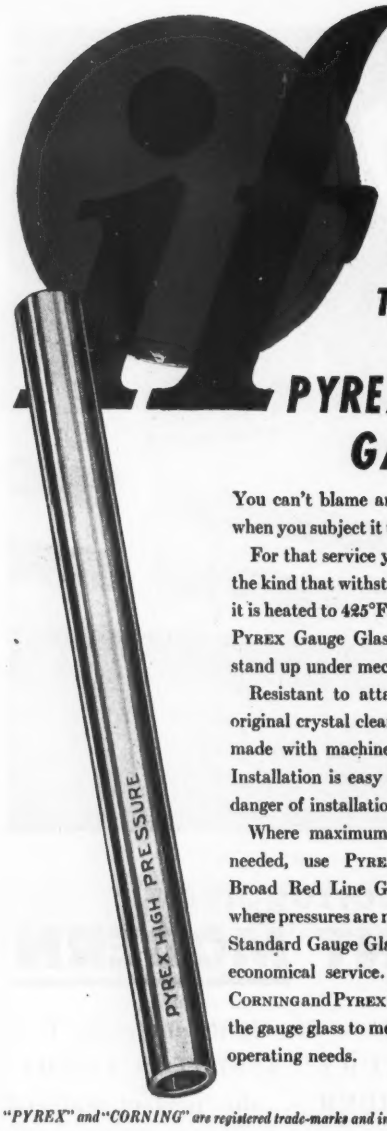


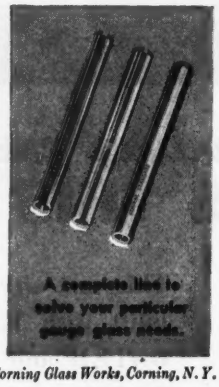
your service
INVOLVES EXTREME TEMPERATURE SHOCKS
use
PYREX HIGH PRESSURE GAUGE GLASSES

You can't blame an ordinary gauge glass for going all to pieces when you subject it to extreme and sudden changes in temperature.

For that service you need a PYREX High Pressure Gauge Glass, the kind that withstands such temperature shocks that occur when it is heated to 425°F. and then plunged immediately into ice water. PYREX Gauge Glasses not only withstand this severe test but stand up under mechanical shock and abuse as well.

Resistant to attack from steam and hot water, they retain original crystal clearness even after long service because they are made with machine drawn accuracy. Installation is easy and there is little danger of installation strains.

Where maximum visibility is also needed, use PYREX Red Line or Broad Red Line Gauge Glasses and where pressures are moderate CORNING Standard Gauge Glasses will give you economical service. In the complete CORNING and PYREX line you can choose the gauge glass to meet your particular operating needs.


A complete line to solve your particular gauge glass needs.

"PYREX" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.

CORNING Glass Works Corning, New York
Pyrex Gauge Glasses

"Boiler Repairs Reduced 75%"
writes user of NATIONAL GIRTH SEAM PROTECTOR

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 740 REIBOLD BLDG., DAYTON, OHIO

ing in that capacity until 1941, when he was appointed manager of electric station operations, the position he held at the time of his selection as vice president.

Philip Sporn, formerly vice president of American Gas & Electric Co., has been elected executive vice president of the company. Mr. Sporn was also elected executive vice president and chief engineer of each of the operating companies of the American Gas & Electric system at meetings of their boards of directors on April 26.

Obituaries

Hans Nielsen Boetcher

HANS NIELSEN BOETCHER, assistant to superintendent of power production stations department, Consolidated Gas Electric Light & Power Co. of Baltimore, died in that city on April 19, 1945, after a short illness. He was 47 years of age.

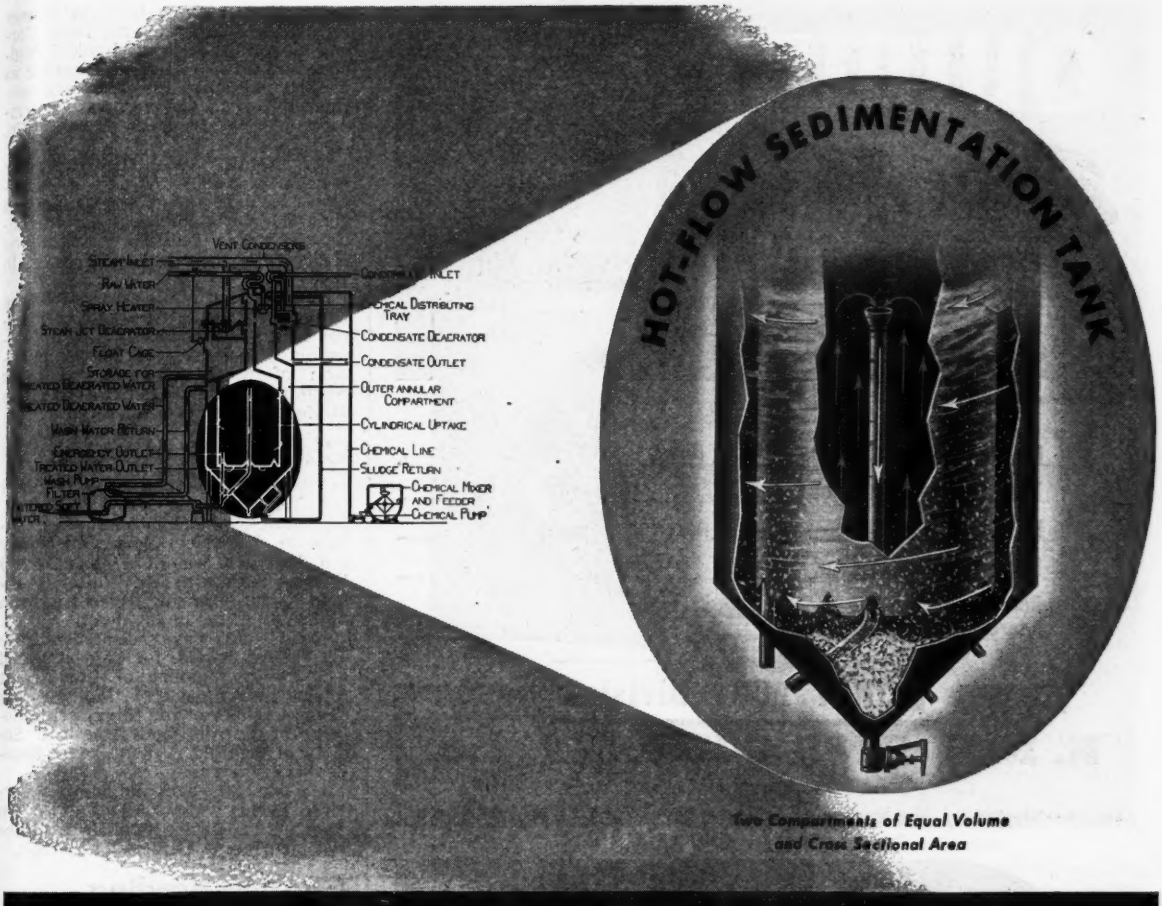
Mr. Boetcher was a native of Hamburg, Germany, and received his formal education at the Technical University in Hannover. Prior to his coming to this country in 1924, he was with the Siemans Electric Works, Hamburg. Continuing in the field of engineering associated with the generation of electric power, he entered the employ of the Consolidated Gas Electric Light & Power Co. in 1925. Engaged primarily with the design, construction and operation of steam electric generating plants, Mr. Boetcher was prominent in recent years in metallurgy as applied to the power industry. He was known as an authority on corrosion and failure of metals in power boilers and other power plant equipment, being the author of numerous papers and studies on these subjects.

His knowledge of metals was also applied to welding, in which he had great interest, and his contributions in this field were in large degree responsible for the rapid advance of this art. He was an associate member of the American Welding Society and was prominent in the organization of the Maryland Section, being local chairman at one time.

He was a member of the ASME, taking an active part in the committee work of that society. He served on numerous committees of the Edison Electric Institute, being a member of the Prime Movers Committee at the time of his death. He was also a committee member of the American Society for Testing Materials, being Chairman of the Subgroup on Graphitization of High Temperature Pipe.

W. R. Webster

WILLIAM R. WEBSTER, chairman of the board of the Bridgeport Brass Co., of Bridgeport, Conn., since 1930 and associated with the concern for 48 years, died April 28 in the Bellevue Stratford Hotel, Philadelphia, Pa., at the age of 77 years. His home was in Bridgeport.



Two Compartments of Equal Volume and Cross Sectional Area

HOT-FLOW SOFTENERS FOR BOILER FEED-WATER TREATMENT . . . .

PLUS VALUE No. 1 SEDIMENTATION TANK DESIGN

EQUAL VOLUMES: The water must spend half its retention time traveling down the outer compartment—so chemical reactions are completed and solids precipitated long before the water turns upward into the inner compartment.

EQUAL CROSS SECTIONS: There is no variation in velocity of forward travel from inlet to outlet—not even at the point of change in direction of flow.

Thus, this design feature establishes an operating condition conducive to maximum solids separation and sedimentation. The result is an ample volume of properly settled, relatively clear water always ahead of the filters, and this

- **permits 350% overload when backwashing**
- **permits full recovery of wash water**
- **increases the length of filter runs**
- **increases the life of filtering media**
- **reduces operating attention required**
- **eliminates the need for any coagulant**
- **assures high clarity of filter effluent**

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QUIMBY
Rotex Pump
THESE 5 NEW FEATURES ASSURE LONGER LIFE, INCREASED EFFICIENCY
1. Double Helical Pumping and Timing Gears:
2. Timing Gears Located at Outboard End:
3. Improved Supporting Feet Ribbed to Nozzles:
4. Heavy Duty Anti-Friction Bearings:
5. Accessible and Interchangeable Parts:
QUIMBY PUMPS
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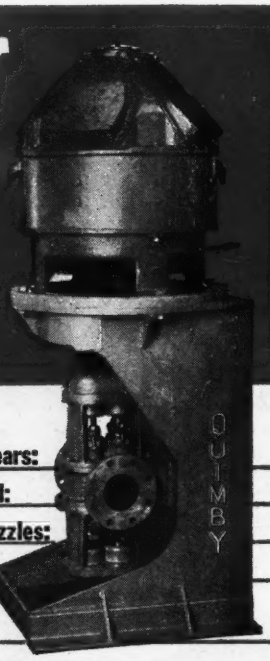
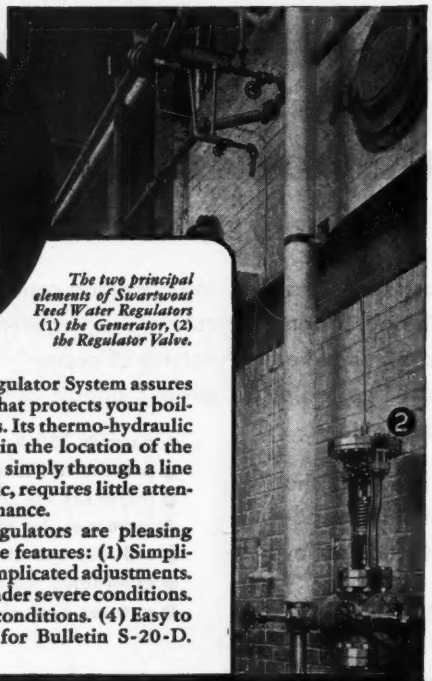


Assure Correct Water Supply to Busy Boilers with
Swartwout Feed Water Regulators



The two principal elements of Swartwout Feed Water Regulators (1) the Generator, (2) the Regulator Valve.

The Swartwout Feed Water Regulator System assures sensitive quick-acting control that protects your boilers from dangerous water stages. Its thermo-hydraulic principle permits wide leeway in the location of the two major elements, connected simply through a line of tubing. Completely automatic, requires little attention and practically no maintenance.

Swartwout Feed Water Regulators are pleasing thousands of engineers by these features: (1) Simplicity of construction—avoids complicated adjustments. (2) Ruggedly built to operate under severe conditions. (3) Easily adjusted to varying conditions. (4) Easy to install on any boiler. Write for Bulletin S-20-D.

Swartwout POWER PLANT EQUIPMENT
THE SWARTWOUT COMPANY • 18511 Euclid Ave., Cleveland 12, Ohio

Mr. Webster was born in Oyster Bay, L. I., and graduated from Cornell University as a mechanical engineer in 1890. He began his career as a sales engineer for Westinghouse, Church, Kerr & Co., and was superintendent of the Bridgeport Copper Co. from 1893 to 1897.

Mr. Webster joined the Bridgeport Brass Co. in 1897 and served successively as department superintendent, general superintendent and vice president. He was elected a director and chairman of the board of directors in 1930.

Mr. Webster was a director of the Bridgeport-City Trust Co. and a member of the Bridgeport Board of Education. For many years he was chairman of the employment relations committee of the National Association of Manufacturers.

Charles G. Heydon

CHARLES G. HEYDON, sales engineer for Wright-Austin Co. of Detroit, Michigan, died suddenly of a heart attack in their New York Office May 9th, 1945. He was on a business trip to New York with Mr. Walter, president of the Company, who was with him at the time of his death.

Mr. Heydon was associated with the Wright-Austin Co. for 25 years, and was a life member of the Ararat Shrine in Kansas City, Mo. He was also a member of the Engineering Society of Detroit, and American Society of Heating & Ventilating Engineers.

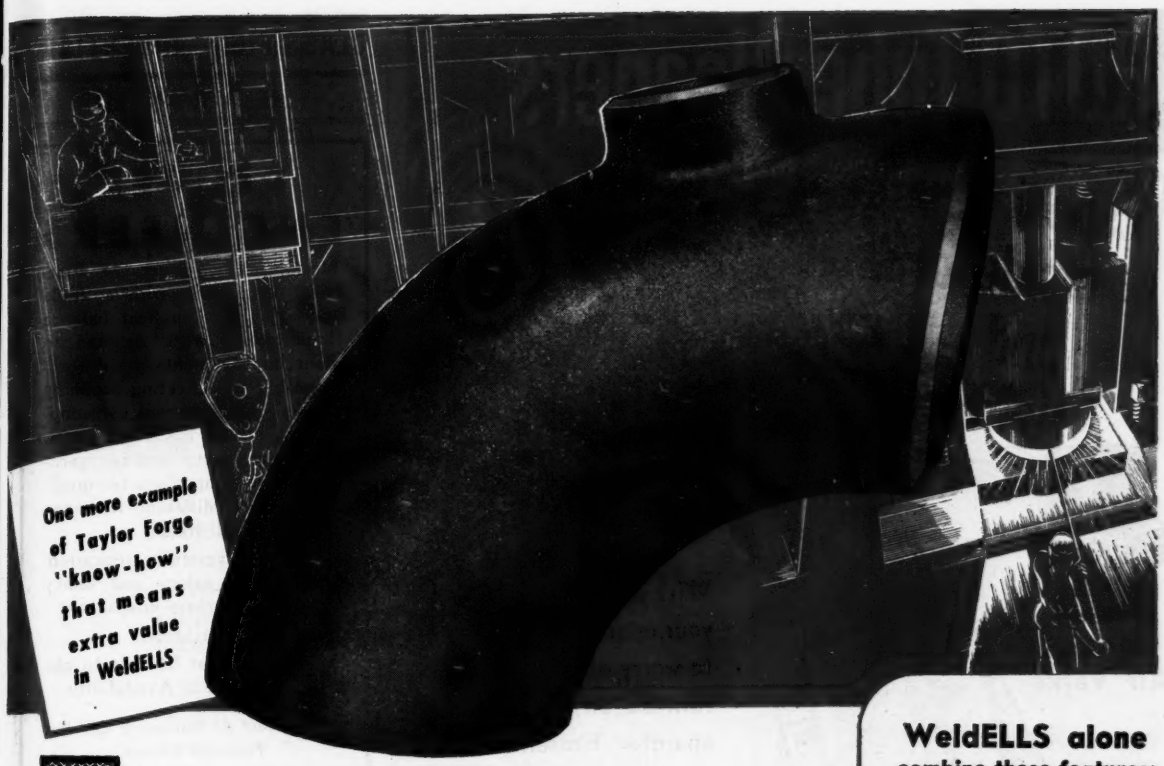
He was 60 years old, and is survived by his widow, Alice, and a son Thomas G. Heydon, who is with the Packard Motor Car Co. of Detroit.

Charles Harding Eastwood

CHARLES H. EASTWOOD, general adverising manager of Wallace & Tiernan and Associated Companies, Newark, N. J., died Friday, April 27, 1945, in the Huntington Hospital, Pasadena, Calif., after a relapse from a heart attack that he suffered six weeks previously.

Mr. Eastwood was born and educated in England; came to Canada with his family as a young man. He enlisted and served overseas in a medical unit of the Canadian Army in World War I, serving with distinction and receiving many honors. After the war, he joined the staff of Nordyke & Marmon—at that time one of the leading builders of flour milling machinery—and joined the Wallace & Tiernan organization on March 1, 1924, confining his early work to flour milling activities.

He became manager of the W & T district office at Jacksonville, Fla., and in 1929 was transferred to the head office in Belleville, N. J., working for a while on export sales before being assigned to responsibility for advertising and sales promotion, finally becoming general advertising manager. In addition, he was directly responsible for the main office management of the Decco Process (citrus fruit decay control) and, for a period of several months in 1943 and 1944, the main office management of the flour milling service division. He had a large, nationwide acquaintance in all W & T fields of interest.



There's always another one for us!

★ *Just when we think we've seen everything in special forged fittings another tricky requirement turns up . . . and probably always will. This time it's an order for seven-inch carbon-moly WeldELLS with integrally formed 3-inch outlets in their back walls.*

We have solved problems that are a lot tougher than this, but none exactly like it. Thus, like hundreds before it, it has contributed its share to the sum total of Taylor Forge "know-how" . . . is one more proof that we have honestly earned our reputation for doing things with hot metal no one else does.

THE unduplicated experience of Taylor Forge in the field of special forging has a vital bearing on your choice of standard welding fittings. It means there is nothing to be desired in welding fittings that is not within the scope of the methods and facilities that have grown out of this experience.

By applying these methods and facilities we have given WeldELLS features that are not combined in any other fittings. A good example of this is the uniform strength achieved through proper distribution of extra metal where stresses are higher. Another, is the extreme dimensional accuracy attained by special truing operations. Still another is the special process which forms the tangents, and there are many more.

This specialized Taylor Forge knowledge is responsible for the features listed opposite—is the reason why those who are best qualified to know will agree that

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends** —simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

WeldELLS have everything

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Especially handy inside drums and other tight spots

ROTO Air Valve

With a Roto Tube Cleaner your operator doesn't have to worry about a helper to turn air on and off. The operator himself controls the entire operation with an air valve located directly behind the motor. You will appreciate the benefits of one-man control because it provides safer, more efficient tube cleaner operation, especially inside drums and other tight spots. Write for details.

Roto Division of Elliott Company
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ALLPAX

THE PACKING THAT "PACKS ALL"

. . . use it once and
. . . you'll use it always

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

THE ALLPAX CO., INC.
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Mechanical Engineers or Electrical Engineers, with aptitude and experience in heat balance thinking for work devoted to plant improvements, results engineering and effecting economy in the generation and consumption of steam, electricity, compressed air, water and refrigeration. Several openings for qualified men at different locations in the United States.

Give full experience, education, age, present salary and salary expected. Enclose snapshot.

Post-war opportunity.

Applicants must be able to obtain Statement of Availability.

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CHANGE OF ADDRESS

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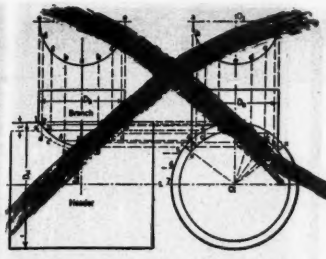
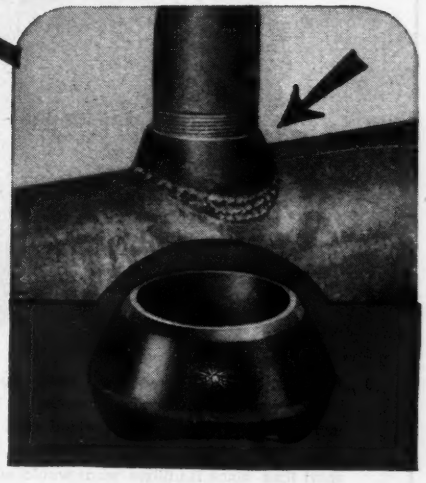
POWER PLANT ENGINEERING



Don't Waste Time with Templates on Branch Pipe Connections



On your branch pipe outlet jobs use the WeldOlet Method. It's a cinch to install WeldOlet Fittings! Whether you have a size-to-size or reducing size job, the WeldOlet Fitting acts as the template. So you save time and money on every branch pipe outlet.

All that plus the low first cost! And with WeldOlet Fittings you can often eliminate one or more welding operations, as the run pipe does not have to be cut in half.

HOW TO MAKE A BRANCH PIPE OUTLET IN 4 EASY STEPS . . .

LAYOUT—Locate WeldOlet Fitting on run pipe where outlet is to be made and mark center lines. Using inside of WeldOlet as template, mark hole to be cut in run pipe with scriber. Center punch along scriber mark to give definite cutting line.

CUT HOLE—Use torch for cutting hole in run pipe. Hold torch at right angles to pipe and follow center punch marks. Use a chisel to remove any icicles or beads, and clean pipe around hole with wire scratch brush.

TACK WELD—Re-position WeldOlet Fitting on run pipe with original center line marks. To get proper penetration of weld metal, separate fitting from main pipe 1/16" to 1/8" by inserting welding rod. Tack weld at 4 points.

WELD IN PLACE—Use either oxy-acetylene or electric arc welding for satisfactory results. Lay down a bead in the bevel between fitting and main pipe. Completely fill bevel at base of fitting with weld metal to obtain a leakproof joint of full, original pipe strength.

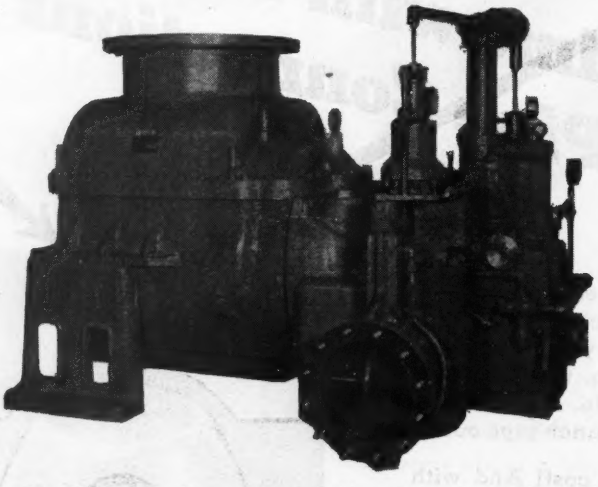
After the WeldOlet Fitting is installed, you can easily inspect the inside of the joint. To meet the needs of various jobs three types of WeldOlet Fittings are available—butt-welding, threaded and socket-welding outlets. Drop us a line today for information on the types to meet your needs. Ask for the Handbook of Branch Pipe Outlets.

Forged Fittings Division

BONNEY FORGE & TOOL WORKS • *639 N. Meadow St., Allentown, Pa.*

WELDOLETS
TRADE MARK REG. U. S. PAT. OFF. PAT. IN U. S. & FOREIGN COUNTRIES
WELDING OUTLET - THREADED OUTLET - SOCKET OUTLET
For Welded Branch Pipe Outlets

MURRAY MULTISTAGE STEAM TURBINES



Another MURRAY multistage steam turbine, designed to deliver 350 horsepower on low pressure steam at 5 pounds and exhausting to 26 inches Hg vacuum. It is provided with single inlet valve with 10 inch flange, and 24 inch exhaust facing up. This unit will pay for itself in a short time, since it utilizes what would otherwise be wasted energy, since an excess of low pressure steam existed.

Equipment includes variable speed oil relay governor, butterfly type emergency trip valve, strainer surrounding the double seated balanced governor valve.

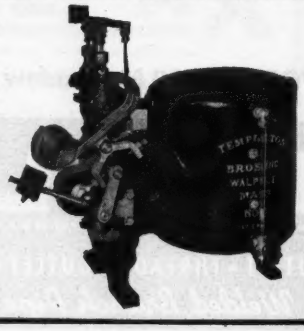
The complete MURRAY line of turbines includes all variations of mechanical drives, and turbine generator sets up to and including 2500 KW rating.

Sales Representatives for Murray products are located in all principal cities.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
Builders of Steam Power Equipment for Three Quarters of a Century

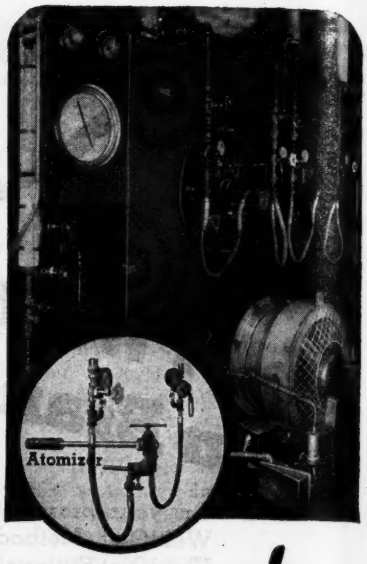
TEMPLETON RETURN STEAM TRAPS
for Pumping, Boiler Feeding, Draining, Heating and Vacuum Lines

Pumps Water at any temperature or pressure.
Open float cannot burst or waterlog.
Valves and Seat Bronze or Stainless Steel.
Sizes 1 in. to 4 in. inlet and outlet.
Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.



Ask for catalogue and prices

TEMPLETON BROS., INC.
699 Main St. Walpole, Mass.



Efficient combustion with Enco Burners

FOR ALL GRADES OF LIQUID FUEL

Enco Burner Units of Steam or Mechanical Atomizing Types are made in various sizes with capacities from 1 to 1000 gallons per hour.

Designed for operation either with or without air registers and for natural or forced draft.

The Enco Interchangeable Atomizer is made for instant change of guns for operation by either steam or mechanical system or to cover a wide range of capacity.

Enco Atomizers are used with various types and makes of pulverized-coal and gas-burner units to provide a dual fuel unit for cold starting, or for full-load operation when coal or gas is not available, or use when oil is the more economical fuel.

We have made many installations during the past 25 years and are ready to cooperate with those looking for better operation and assurance against loss of steam output.

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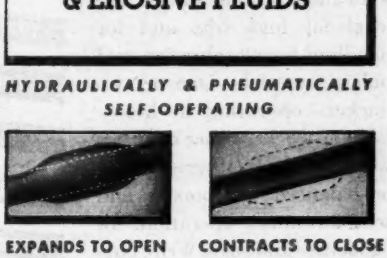
NO Seep!
NO Leak!

...IN HANDLING
LIQUIDS & GASES
Including: *HIGHLY*
CORROSIVE
INFLAMMABLE
& EROSIVE FLUIDS

Set it!—and forget it!

● The New Grove Flexflo, fully self-contained Back-Pressure Regulator or Relief Valve provides positive *bubble-tight* shut off and insures absolute *leak-proof* control of even the most severe and hazardous types of liquids or gases. A pressure-actuated synthetic rubber tube contracts to close, *tight*—sealing off the flow ...and *instantly opens* with the slightest increase in line pressure. It is impossible to become corroded or stuck and automatically self-compensates for erosion or wear. With no packing glands or stuffing boxes, there is never any danger of seepage, leakage or failure. Once you set it—you simply forget it.

HYDRAULICALLY & PNEUMATICALLY SELF-OPERATING



EXPANDS TO OPEN — CONTRACTS TO CLOSE

GROVE *Automatic... Self-Operating* FLEXFLO
BACK PRESSURE REGULATOR—OR RELIEF VALVE

GROVE REGULATOR COMPANY
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ECLIPSE SEAMLESS METAL HOSE

Flexible AS A GRASS SKIRT

For Handling
OILS • CHEMICALS • GASES
STEAM • HYDRAULIC • ETC.

Bendix Engineers will be glad to help you prevent costly production shutdowns due to failure of Boiler Tube Cleaners, Diesel Exhausts, Lube Oil or Steam Lines, or other lines where flexing vibration are part of the job.

Specify Eclipse Seamless Metal Hose for these tough spots. Built with deep uniform side-wall corrugations, it combines maximum flexibility with long, low cost service.

Comes in monel ⅛ in. to 2 in. I. D. steel hose can be produced up to 40 in. Let us help work out your conveying problems on non-solids and non-abrasives.

Write For Helpful Metal Hose Handbook; It Is Sent FREE

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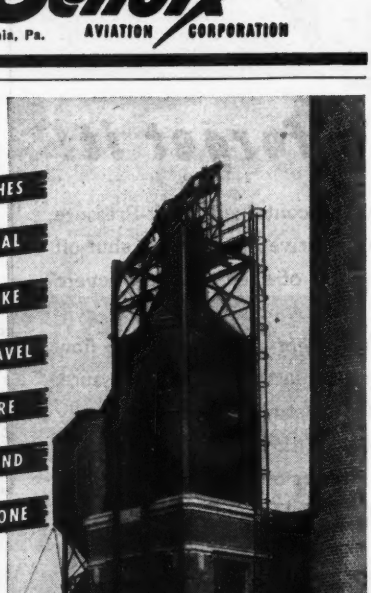
Precision Equipment by **Bendix**
AVIATION CORPORATION

Dept. 19—Phila. Div.—Philadelphia, Pa.

DO YOU handle any of these materials in bulk?

ASHES
COAL
COKE
GRAVEL
ORE
SAND
STONE

• Beaumont Skip Hoists are ideal for high lifts and for handling heavy, abrasive and bulky materials. One or two buckets operating in heavy I-beam tracks, either counterweighted, un-counterweighted or balanced. Automatic and semi-automatic operation. All capacities and sizes. Write outlining your requirements for our engineer's recommendations and quotation.



Heavy I-beam Tracks
In the installation illustrated, the skip hoist handles both coal and ashes alternately, in same bucket, and discharges to either coal or ash bunkers.

BEAUMONT BIRCH COMPANY
1503 RACE STREET PHILADELPHIA 2, PA.
DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS

Ask the Oakite Representative about descaling

Air Compressor Water Jackets

Water jackets and jacket lines of air compressors should be checked and cleaned at frequent intervals for efficient operation and long life of the unit.

Heavy scale present acts as an insulator reducing cooling efficiency, and can be removed from jackets by circulating a solution of specialized Oakite Compound No. 32, a highly effective, controlled acidic material, which can be forced through the jackets by means of a small circulating pump or run through from a container placed above the cylinders.

FREE Digest Gives Details of 71 Different Maintenance Jobs!

Write TODAY for a FREE 20-page valuable Oakite Digest which is filled with facts of power plant engineers' experience using Oakite materials and methods to help insure longer equipment life.

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Technical Service Representatives Located in All Principal Cities of the United States and Canada

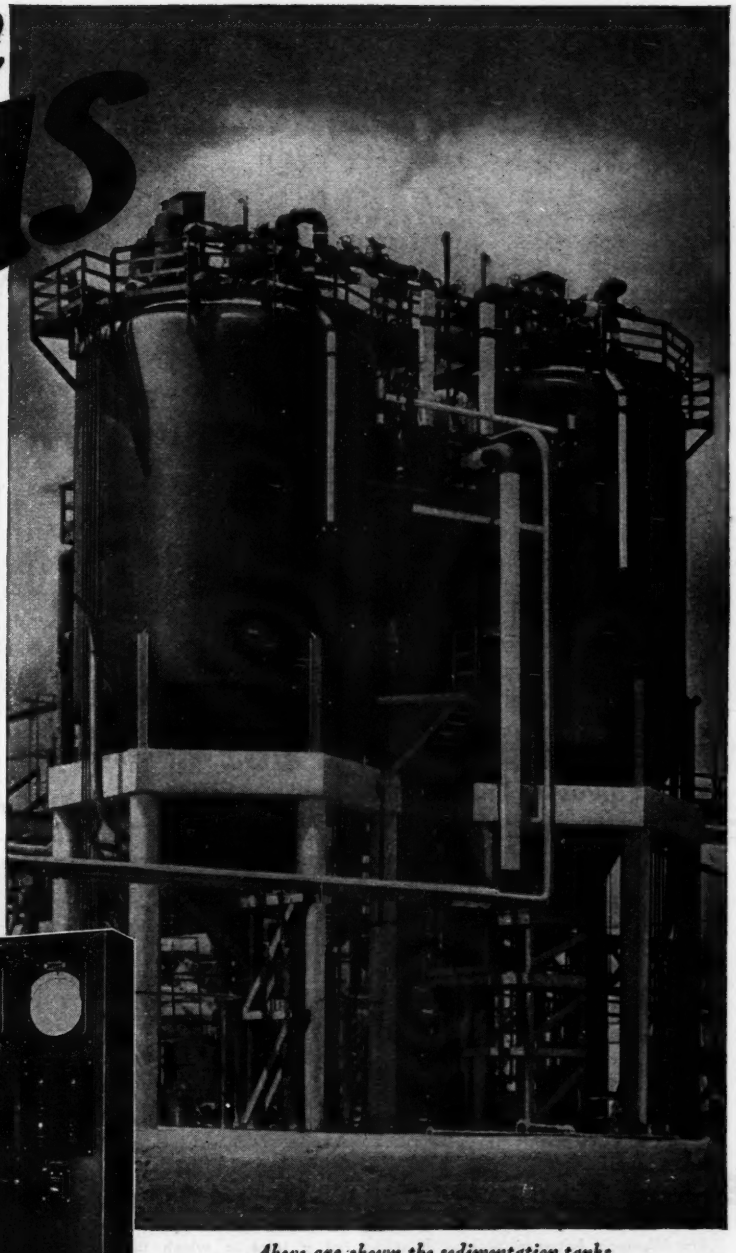
OAKITE Buy Bonds for Victory
Specialized cleaning
MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

2 sets of TWINS

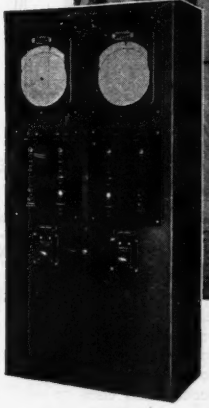
each with a capacity of

50,000 Gals. per Hr.

An interesting installation of Cochrane Deaerating Hot Process Softeners is that of a Southern oil company, which has erected two double-unit softeners, with a total capacity of 200,000 GPH. River water, already treated with coagulant and dolomitic lime in a preclarifying system, is introduced into the Softeners, which have 60° sludge cones. Reagents used are lime and soda ash. One installation uses Cochrane electrically operated proportioners to control individual chemicals; the other installation uses dry feeders. The battery of nine 10-ft. filters have individual valve nests so that they can be back-washed in the conventional way or with filtered water.



Above are shown the sedimentation tanks of one of the twin units. Note 60° sludge cones.



Panel Board with Flow Meter Control of Chemical Feed

COCHRANE CORPORATION
A DIVISION OF AMERICAN ENGINEERING COMPANY

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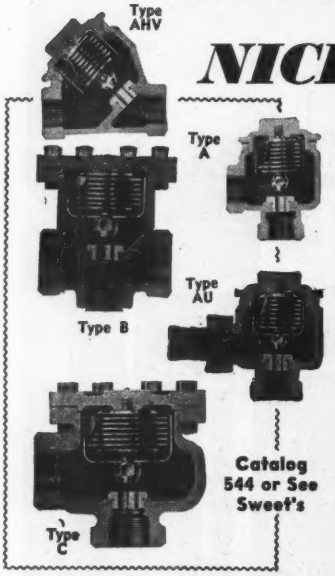
COCHRANE

SOFTENERS · DEAERATING SOFTENERS · DEAERATORS · METERS · STEAM SPECIALTIES

Speed Up
STEAM CIRCULATION
WITH
NICHOLSON
INDUSTRIAL THERMOSTATIC **TRAPS**



Here are six big reasons why Nicholson Steam Traps have outstanding records for promoting better steam circulation and heat transfer:

1. NO AIR-BINDING. Discharge air as efficiently as water.
2. NO FREEZE-UPS. Of thermostatic bellows type; drain completely when cold.
3. NO DRIBBLING. Close immediately when steam contacts bellows.
4. NO ADJUSTMENT NEEDED, from vacuum up to maximum pressure.
5. NO WATER-LOGGED UNITS. A few degrees change opens valve.
6. BIG DISCHARGE CAPACITY, 2 to 6 times that of average traps.

Five types: sizes ¼" to 2". Pressures to 225 lbs. For more details write for Bulletin No. 544.

Catalog 544 or See Sweet's

W. H. NICHOLSON & CO. 160 OREGON ST. WILKES-BARRE, PA.

Valves • Traps • Steam Specialties

This Welded Joint

Eliminates Protrusions in pipes!

The Westport Patented Welded Joint provides a smooth pipe contour at the base of every weld.

There are no "icicles" . . . no protrusions!

This new method, especially suitable in the welding of heavy wall piping for high-pressure-temperature conditions, is proving satisfactory in lines operating at 1250 pounds per square inch and 925 degrees F. total temperature steam service.

Mitchell's service includes this Westport method, which consists of the use of a joint in which the ends to be welded are formed and machined to provide a special U-shaped groove, joining the lips at the root of the weld by the oxyacetylene process and completing the joint by the usual electric arc procedure.

Important: With the Westport Joint, there's no sacrifice in the strength of the pipe due to removal of wall or Backing Ring . . . there are NO gaps between rings and inside of the pipe wall . . . and there's greater flexibility in alignment of pipe, valves and fittings!

WRITE WITHOUT DELAY FOR FULL DETAILS

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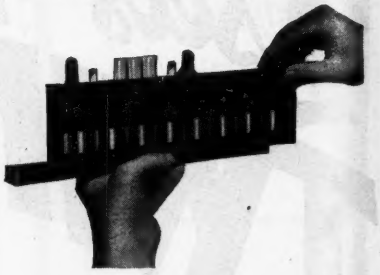
1899 — 1945

Keep Tab with a Miniature Lab



You CAN MAKE ACCURATE, SPEEDY DETERMINATIONS OF pH and PHOSPHATE IN 3 EASY STEPS WITH TAYLOR COMPARATORS

pH in 60 seconds
phosphate in 2 minutes

FREE BOOKLET

Describes modern scientific outfits (priced as low as $19.00), and improved methods employed by industry to step up boiler efficiency and prevent damage to equipment caused by scale, corrosion and embrittlement. Accuracy is Assured for ALL Taylor Liquid Color Standards Carry An UNLIMITED GUARANTEE AGAINST FADING.

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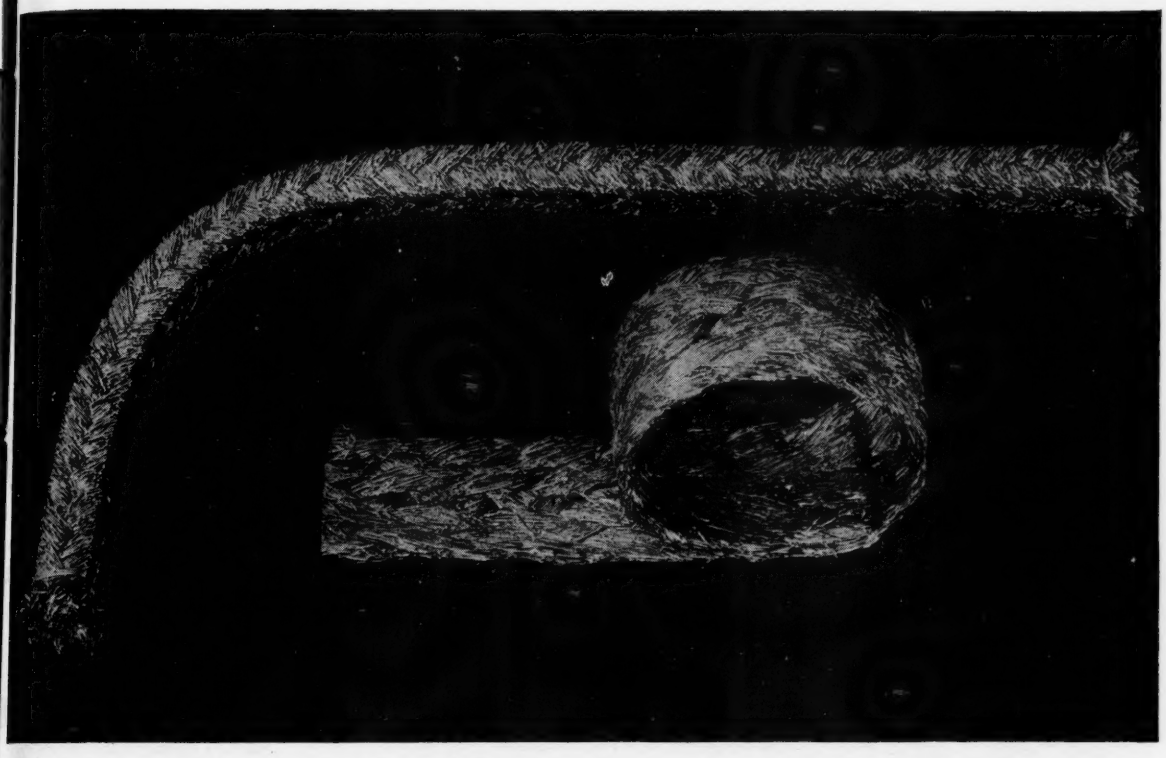


WHAT JOBS DO YOU HAVE FOR THIS NEW TYPE PACKING?

Can you use a packing that's resilient enough to absorb vibration between stationary and moving parts... thermally durable enough to stand temperatures up to 2000°F.... and inert enough to resist corrosion by gases, alkalies and most acids?

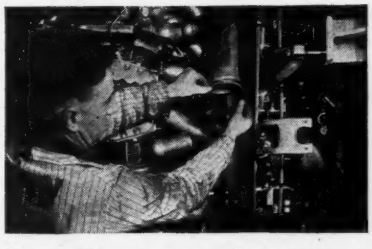
If the answer is "Yes," you'll be interested in the packing illustrated.

Its development began when an improved seal was needed in the exhaust line joints of Uncle Sam's airplanes.

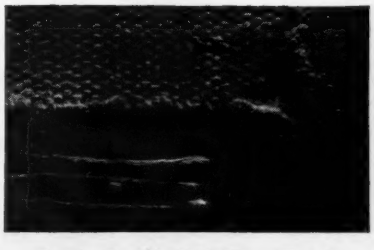
Corrosive, flaming, exhaust gases quickly char ordinary organic substances. And, materials that can endure the heat, soon disintegrate under incessant vibration.

But Johns-Manville engineers found a way to lick the problem. They had thin strands of Inconel knitted into mesh. Inconel was chosen because it offered unmatched thermal endurance plus the required resistance to both vibration fatigue and corrosion. Then, they braided the mesh with an asbestos sealing core and compressed it to the desired shape and size. Result: a resilient *packing that doesn't shake to pieces—nor wilt under high heat.*

Now, to find how the packing problem you have in mind can be worked out with this new type packing... just turn the question over to Johns-Manville Corp., 22 East 40th St., New York 16, N. Y.



INCONEL MESH-ASBESTOS PACKING *being installed in an exhaust line joint of a Superfortress. Produced by Johns-Manville, this type packing is available as strip, half-round or square cross-sections in standard and special sizes. Also made of Monel or pure nickel. (Photo courtesy of Boeing Aircraft Company)*



Another Possible Aid in Power Plants!

CLOSE-UP SHOWS MONEL-ASBESTOS CLOTH *also devised by Johns-Manville. Used to insulate marine turbines. Each thread consists of fine Monel wires, twisted with asbestos yarn. Monel withstands corrosive sea air . . . pounding vibration . . . temperatures up to 850°F.*

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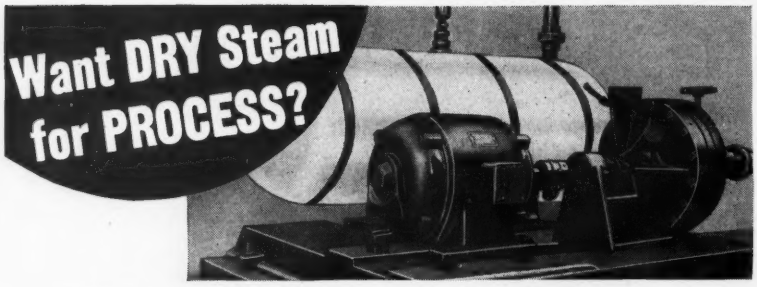


The Stout NO-VENT Boiler Return System Will Give It to You All the Time

The Stout NO-VENT System will do this without reducing valves, orifices, traps or steam reheating. By keeping the lines and condensing units continually free from condensate there is no chance for wet steam anywhere.

Operators of soy bean mills and others who thought they had to use reduced pressures in their driers, expellers and cookers to secure drier steam and hotter units are getting much better results since they discarded their reducing valves and all the other equipment for returning condensate through vented trap systems.

The Stout NO-VENT System collects condensate as fast as formed, frees it automatically of air, foul gases and non-condensibles and returns it directly to the boiler at the same pressure and temperature at which the steam is condensed, losses due to radiation and conduction excepted. It is simple, foolproof and time tested; insures hotter units and *increased production.*

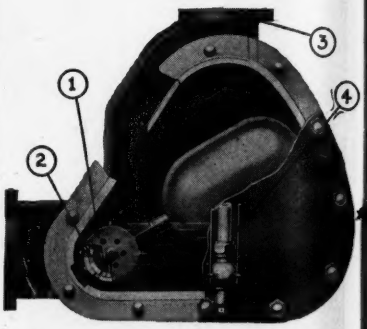
DAVID STOUT & SONS • 6 N. Michigan Ave. • CHICAGO 2, ILL.

Heat Reclaimers • Steam Condensers • Spiro Water Heaters • Gas Fired Boilers

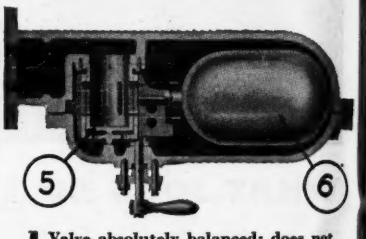
Write for bulletin showing hookup of Stout NO-VENT System and giving operating details. Made in capacities 100 to 800 bhp, pressures to 200 lb. Distributors will be interested in selling franchise.

Stout NO-VENT BOILER RETURN SYSTEM

Extraordinary Discharge Capacity



COCHRANE DRAINER



1 Valve absolutely balanced; does not bind or stick; water sealed; never leaves its seat; self-cleaning; has large ports for handling water rapidly and less operating pressure is required to expel condensate; pilot valves are unnecessary; no stuffing boxes, packings, springs or links; valve can be held open by handle on cover.

2 Valve Seat; a sleeve with longitudinal ports; removable after loosening screws.

3 Inlet at top: no possibility of trap becoming air bound; deflector prevents entering water from striking float.

4 Gauge glass, with guards and try cock.

5 The Rotary Valve Seat is attached directly to float stem; one moving element.

6 Upon taking off cover, the float and attached valve lift out at once.

Write today for further particulars

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A DIVISION OF AMERICAN ENGINEERING COMPANY
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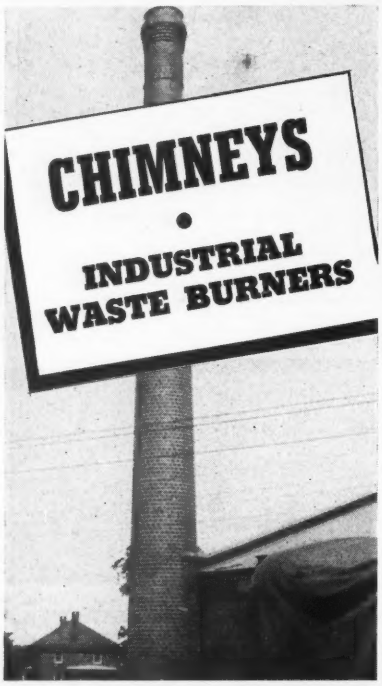

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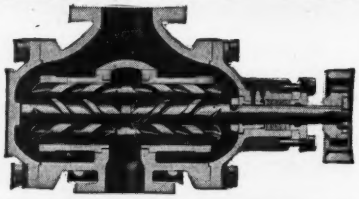

THE PUMP *without* PULSATION

The steady, uniform flow produced by the continuous turning of the rotors in an IMO pump is ideal for oil burners, hydraulic and other service requiring an even, pulsation-free flow.

For information send for Catalog 1-120-0

IMO
PUMP DIVISION OF THE
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

Crystolon Brick FOR

LONG SERVICE

TOP CAPACITY

LOW UPKEEP

CRYSTOLON Brick by Norton will give long, economical service at top capacity and will reduce maintenance time and expense when used at the clinker line of coal-fired boiler furnaces, in the bridge wall and front wall. These highly refractory silicon carbide brick have great resistance to abrasion, to spalling and to the chemical and physical action of molten slag. Slag may adhere to the brick to a very limited degree, but it is easily removed without harming the surface of the wall.

NORTON COMPANY - Worcester 6, Mass.

Norton Longer Lasting Refractories

here is a thought on the subject of WATER TREATMENT...

(. . . for those who sit in the front office)

"Water treatment is a scientific subject through and through and should be treated as such. Industry can obtain *maximum* benefits from water treatment *only* when the formulae and administration of water-treating chemicals are placed in the hands of a company that looks on water treatment through the eyes of a scientist. The men in your plant, your operating engineer or master mechanic, who see *first hand* how scale, corrosion, foaming and algae can lower the efficiency and production in your plant—the recommendations of these men should be management's guide in selecting the company entrusted to solve its water treatment problems."

Photo in Nalco Laboratories

Says

Bob Moran

Nalco Representative, New England

THE SYSTEM OF SCIENTIFIC WATER TREATMENT

Nalco

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Ave., Toronto, Ontario

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 **Non-Clog Stoker**—New bulletin tells why tramp iron and other foreign objects won't jam up the AE perfect spread stoker. Suited for steam requirements from 175 hp to 200,000 lb per hr. American Engineering Co.

2 **Smoke and Combustion Indicator**—Bulletin describes the Ess smoke and combustion indicator which enables operators to see the flame characteristic, make burner adjustment, save fuel. Ess Instrument Co.

3 **Boiler Gages**—New bulletin tells about the Ernst split-gland adjustable water gages for boilers. Glasses may be changed in 1/5 time required for ordinary gages, it is claimed. Ernst Water Column & Gage Co.

4 **Heat Insulation Handbook**—Besides describing five new H-W insulating brick of interest to refractory users, a recent Harbison-Walker book shows typical furnace applications, handy chart for figuring heat losses in Btu per square foot of wall area, and other thermal data. Harbison-Walker Refractories Co.

5 **Boiler Data Book**—Bulletin B-44-5-M on the S-A type boiler has been issued by Foster Wheeler Corp. It contains drawings and photographs, together with operating data at a number of well known plants. Method of operation, ability to fire two or three different fuels simultaneously are discussed.

6 **Uniform Feed Coal Conveyor**—New Folder No. 2068 tells about the uniform feed, automatic discharge, low headroom and other features of the Link-Belt Sidekar-Carrier for boiler and coal preparation plants. Contains many installation photos and operating diagrams. Link-Belt Co.

7 **Automatic Valved Soot Blowers**—Positive closing, reduced pressure blowing, 360 deg. blowing arc, and other operating features of Diamond automatic valved soot blowers are described in Bulletin 884-A. Contains helpful ideas on soot blower piping practice. Diamond Power Specialty Corp.

ELECTRICAL

8 **First Aid for Ailing Motors**—What to do when motors run a fever, hum, spark at brushes, won't start, etc., is explained in Allis-Chalmers' new "Guide to Wartime Care of Electric Motors." Over 100,000 copies already in use.

9 **Lighting Hangers**—Specifications for the new Thompson 3-way, 4-wire, 4-pole disconnecting, lowering hangers, are included in 20 pg bulletin. These hangers are designed for use with high-positioned combination twin or triple unit mercury or incandescent lighting equipment; also where color lighting or various degrees of illustration are required. They permit floor or ground level washing, relamping of and repairs to the lighting fixtures at low cost. The Thompson Electric Co.

10 **Where-to-Use Motor Data**—Condensed Motor Catalog No. GEA-4281 gives ratings, sizes, characteristics, dimensions, where-to-use data, and prices of General Electric a-c and d-c motors, 1/16 to 75 hp.

11 **Data on Induction Heating**—Information on the first standard mercury arc converters designed for induction heating operations in the 500-2000 cycle frequency range is presented in a well-illustrated 8-pg bulletin just issued by the Allis-Chalmers Mfg. Co. All essential apparatus for complete installations, including coils, furnaces, and cubicles are described by a drawing and wiring diagram of a typical mercury arc converter installation. As frequency changer equipment, the Excitron mercury arc converters have a conversion efficiency of 90 per cent or better. Units are built to supply power for induction heating in blocks of 250, 500, and 1000 kw and higher.

12 **Insulation Tester**—The new U. S. made "Megger" insulation tester, in plastic molded case, and said to have the same ruggedness and accuracy common to all "Megger" instruments, is described in new Bulletin 1735-PE. James G. Biddle Co.

FANS, PUMPS, COMPRESSORS

13 **Single Stage Centrifugal Pumps**—Bulletin No. A145 describes construction details, methods of drive, typical performance charts of Economy single stage double suction centrifugal pumps. Also has application photos in paper mills, water supply plants, etc. Economy Pumps, Inc.

14 **Centrifugal Pump Manual**—Conveniently tabbed file-size catalog describes Weinman Unipumps for general service, split-case centrifugal pumps, non-clog pumps, sump pumps, etc. Includes useful pump instruction manual and hydraulic engineering data. The Weinman Pump Mfg. Co.

15 **Gas Engine Driven Compressors**—Ingersoll-Rand announces a catalog describing KVG 4-cycle V-angle type gas-engine-driven compressors. Type KVG, from 600 to 1000 hp, was brought out to fulfill the demand for larger compressors of this type for refining and services such as repressuring, recycling and gas distribution.

16 **Hydraulic Pressure Pumps**—Bulletin 238 describes the smooth flow, elimination of plug leaks, greater accessibility of Warren duplex hydraulic pressure pumps. Also has table of pump sizes and capacities. Warren Steam Pump Co.

17 **Screw Pump Data**—Absence of pulsation and vibration, low maintenance, and other advantages of Sier-Bath screw pumps are discussed in new bulletin. These units was widely used for fuel oil service, sprinklers, handling of heavy viscose materials. Bulletin has pump recommendation charts and other useful engineering data. Sier-Bath Gear Co., Inc.

18 **Pump Applications**—Recent issue of "The Blackmer Swinging Vane" magazine describes interesting pump applications in lifeboats and fishing boats; includes useful engineering table on Pressure Drop in Air Lines. Blackmer Pump Co.

INSTRUMENTS AND CONTROLS

19 **Temperature Controls**—Blue Book, Part 4, issued by H-B Instrument Co., tells about its relay units and thermo-regulators. These controls—accurate within 1/10 of 1 deg F—are used for insuring constant temperature of ovens, heating baths, refrigerants, rooms, etc. Contains wiring diagrams and other useful engineering data.

20 **Combustion Control Equipment**—Bulletin BD-44, 12 pages, describing a practical low cost balanced draft system that automatically controls furnace pressure, steam pressure, fans and stokers. The Enco Balanced Draft has been in use on more than 1,000 boilers in prominent power plants. The Engineer Co.

21 **Air or Water Operated Pressure Controllers**—Leslie Co. describes a new rugged industrial controller suitable for either air or water operation in Bulletin 402. Controller is adjustable for non-continuous leakage. Complete line of diaphragm regulating valves included.

22 **Gages for All Kinds of Liquids**—Bulletin 1037 describes a complete line of liquid level gages for measuring liquids of all kinds whether light or heavy. Dial readings can be provided in feet, inches, gallons, pounds, liters or by any other desired increment. The Liquidometer Corp.

23 **Industrial Thermometers Manual**—A 64-pg comprehensive reference to their high-accuracy mercurial industrial thermometers and related instruments is available from Precision Thermometer and Instrument Co. Princo instruments described cover a wide range of industrial uses, including power plants, chemical and process industries, refrigeration, air conditioning, food processing, warehouses, paint and varnish manufacture, pipe lines, pumps stills and boilers and similar applications.

MECHANICAL TRANSMISSION

24 **Folder Describes New Belt Hooks**—The Bristol Co., Mill Supply Division, has just announced the publication of a bulletin describing its new line of wire belt hooks for all types of flat belting. The bulletin is liberally illustrated to show method of applying hooks to belts. Specification information and prices are also given.

25 **V-Belt Data Book**—How Veelos link construction provides quick, easy tension adjustment and other advantages in V-belt drives is illustrated in 8 pg bulletin. Contains sample calculation for engineering a Veelos drive and other useful V-belt information. Manheim Mfg. & Belting Co.

26 **Transmission for 1 to 30 hp Motors**—"As many as 500 in a plant," is the title of the new 6-pg bulletin describing three models of Western Transmissions for motorizing various cone driven machine tools. It illustrates how Multi-motor-mounts (up to 30 hp) may be adapted to most any cone driven machine tool. Western Manufacturing Co.

27 **Allspeed Drives**—Plant engineers report production increases as high as 200% with the application of Worthington allspeed drives, described in new bulletin. Unit provides instantaneous, variable speed control without stopping operating machine or motor. Worthington Pump and Mach. Corp.

28 **Speed Reducer**—4-pg folder on Bowes Drive, an electric device for speed reduction between modern high-speed prime movers and drive shafts, contains photographs of unit and its component parts, together with description of operation and other data. Elliott Co.

29 **Z-Metal Chain Belts**—New 4-pg folder gives practical information on Rex Z-Metal chain belts and their application. One of the advantages claimed for this casting is its remarkable resistance to corrosion due to the patented process of manufacture. Pintle, roller and other popular types of chains available in Z-Metal are illustrated. Chain Belt Co.

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JUNE, 1945

POWER PLANT ENGINEERING

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PRIME MOVERS

30 **Engine Silencer** — New bulletin describes construction and operating advantages of Sims-Whittington cyclone type silencer and spark arrester for internal combustion engines. Will clean gases exhausting from engine outlets from 1 in. through 18 in. The Sims Co.

31 **Turbines and Condensers**—New bulletin tells about construction and performance of Worthington turbines, turbine generator units, surface condensers, circulating pumps, water softeners and other power plant equipment. Also gives pressure-temperature conversion table and other useful engineering data. Worthington Pump and Mach. Corp.

32 **Rubber Insulated Engine Mountings** —A simplified means of selecting rubber insulated engine mountings that stop engine vibration is contained in Bulletin BU-23, issued by Bushings, Inc. Contains a simplified formula for calculating the proper mounting for any given load, as well as dimension drawings of four typical mountings capable of handling loads of from 20 to 600 lb.

33 **Diesel Engine Oil**—New bulletin covers 500-hour test run data on Vital Diesel oil. "Overall piston cleanliness higher than average—top ring groove is clean—all rings free," were among summary comments. E. F. Houghton & Co.

WATER TREATMENT

34 **Feedwater Treatment** — Recent 4-pg reprint No. 37 discusses feedwater treatment for high-pressure boilers at Dow Chemical Co. Cochrane Corp.

35 **Purification of Hydrous Oxide Sols**— Reprint of article by John W. Ryznar outlines a new method of preparing and purifying hydrous oxide sols through use of ion exchangers. Method is said to be simple, inexpensive. National Aluminate Corp.

36 **Chemical Feed Systems**—Bulletin 451 explains why two distinct systems are recommended, for feeding Sodium Sulfite into feed water lines and for feeding other chemicals directly into the boilers. It lists the various units by code number, by boiler pressure, by make-up water requirements, etc., so that the power plant engineer may select a unit of proper capacity, get a quotation, buy and install just as he does an electric motor, a new pump or some other piece of equipment. Milton Roy Pumps.

37 **Ion Exchangers**—Bulletin No. 1960 describes the action of Infilco ion exchangers which utilize principle of ion exchange of sodium for calcium and magnesium, hydrogen for other metallic ions present, etc. Many flow diagrams, installation photos and data useful to water treatment engineers. Infilco, Inc.

38 **Chemical Feeders**—Bulletin describes Manzel chemical feeders for automatic boiler feedwater treatment. Installed on boiler pumps, they automatically feed a small amount of chemical into the line with each pump stroke. Easily adjustable to fit your exact requirements. Manzel Brothers Co.

WELDING

39 **Welding Ideas for Maintenance**—How to reclaim coal pulverizer shafts, prevent wear on valves, repair worn pump impellers and do many other jobs are described in 16-pg booklet "101 Welding Ideas for Low-Cost Maintenance." The Lincoln Electric Co.

40 **Welding Reference Chart**—A new, invaluable reference chart for welders, which points out the proper shades of filter lenses to wear for different types of welding operations, is announced by the American Optical Co. The chart will help every welder simplify and speed up his work in addition to guarding his eye-sight. For example, in oxyacetylene torch cutting and welding, the shades of filter lenses are classified according to whether the cutting or welding is light, medium or heavy. Shades for electric welding are classified according to the different diameters of the welding rods.

41 **Solder Backed Contacts for Brazing**— Gibson Electric Co. has published a new folder covering silver-solder-backed contacts in Gibsiloy and silver for brazing. The construction and advantages of solder backed contacts and various methods of brazing are described in detail. Listings and illustrations of standard forms and sizes in which solder backed contacts can be furnished are shown.

(Continued on page 190)

VIKING

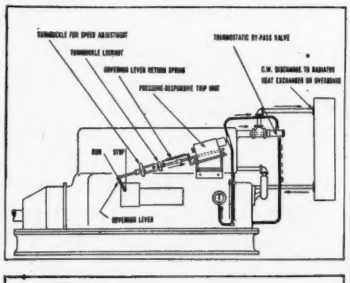
DIESEL ENGINE "SHUT-DOWN" SAFETY CONTROL

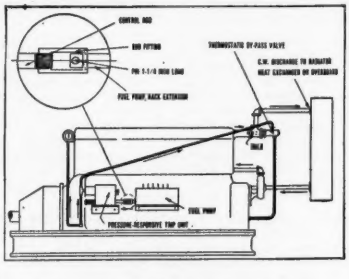
The Viking Type R-18 Shut-Down System for Diesel Engines, is a unique mechanically-operated safety control to shut down a diesel engine when (1) lubricating-oil pressure becomes too low, or (2) circulating-water temperature becomes too high.

Since it is mechanically operated this system does not require any electrical connections, and is free from operating failure due to blown fuses or other failure of electrical power sources.

A pressure-responsive bellows unit is connected in the lubricating-oil line and operates by trigger action a governor lever which shuts down the engine as soon as lubricating-oil pressure reaches the critical low point; similarly, a thermostatic by-pass valve in the circulating-water system will operate the lever when temperatures become excessive. Write for Data Sheet R-18.

TYPICAL APPLICATIONS





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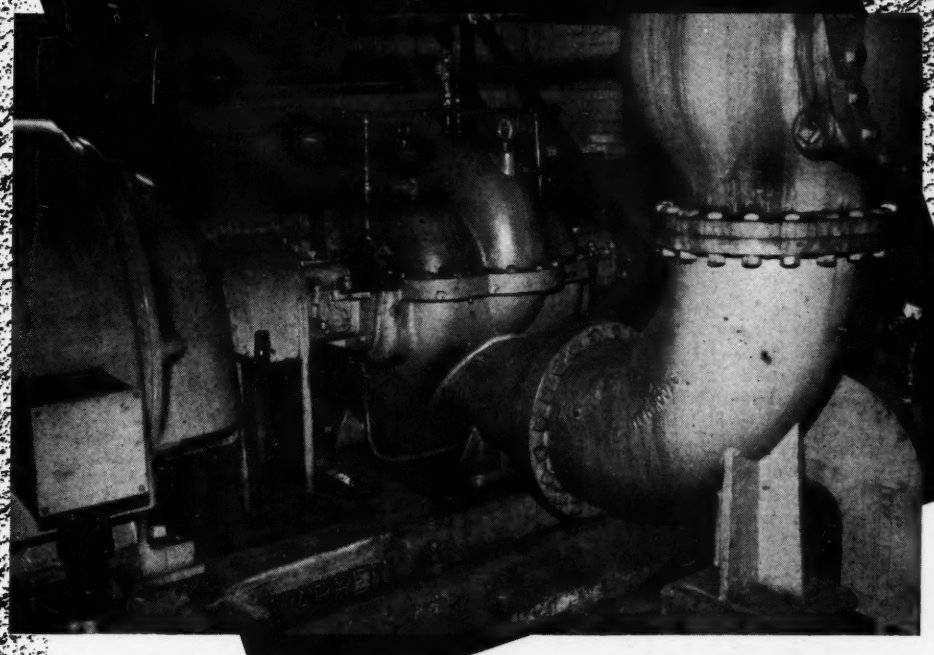


. . . INCLUDING PUMPS in the case of this large eastern seaboard refinery which has several Warren installations.

WARREN PUMPS

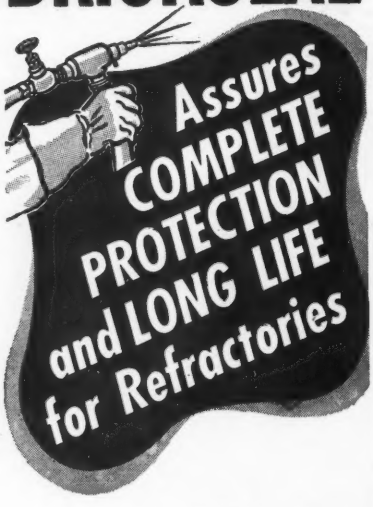
Among these is the salt water pump illustrated which has been on the job since 1936 . . . literally on the job with a perfect "attendance record". This is a 20" single stage, double suction, all bronze pump known as Warren 20-DL-22 Capacity, 14,000 GPM. Other DL type pumps available in capacities from 500 to 40,000 GPM.

For complete details ask for Bulletin 227

ARMY ★ E ★ NAVY

WARREN STEAM PUMP CO., INC.
WARREN, MASSACHUSETTS

BRICKSEAL



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monolithic coating

prevents cracking and spalling

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Brickseal should not be confused with ordinary air-set washes which form a plaster-like surface coating. Brickseal consists of high-fusion clays and metals combined in oils. Furnace heat burns the oils and vitrifies the clays and metals, which penetrate deeply into all pores, cracks and joints, binding the bricks into a durable, monolithic wall.

Brickseal cannot crack, blister or peel off due to sudden temperature changes because, at operating temperatures, it becomes semi-plastic, permitting it to expand and contract with the wall.

Brickseal also binds old cracked or loosened bricks. Slag may be removed without damage to lining.

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Plants at
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5800 S. Hoover St., LOS ANGELES 44, CALIF.

42 **Review of Welding Progress**—Attractively illustrated booklet "The Future of Welding," highlights progress made in gas, electric and resistance welding; describes modern welding equipment. Victor Equipment Co.

MISCELLANEOUS

43 **Cast Iron Fin Type Radiation**—D. J. Murray Manufacturing Co. 6-pg folder describes the cast iron "fin" type radiation, (patented) design and construction. Contains charts and illustrations, with installation views of cast iron Grid unit heaters, dimensional drawings, capacity tables, supply and return connections drawings, etc. Explanation of "carry-over" of heat due to material of construction.

44 **Dust Collecting Systems**—Pictorial catalog shows typical installations of Kirk & Blum pneumatic dust collecting and conveying units in paper mills, textile mills, shoe factories, food plants, etc. Also gives performance data. The Kirk & Blum Mfg. Co.

45 **Water Hose Data**—Containing data on sizes, number of plies, weight per hundred feet, outside diameters and working pressures, a new catalog section on its line of water hose for industrial plants has been published by The B. F. Goodrich Co. Construction of the three types of hose in this line is described.

46 **Waterproofing and Leak Sealing Compound**—Booklet describes compound that seals leaks against water pressure—waterproofs walls—seals concrete water tanks or vats. Comes in liquid form and, when added to concrete mortar, sets up quickly—protects against dampness and underground seepage. Flexrock Co.

47 **Thermal and Bottle Oilers**—Bulletin No. 28-A describes a modernized, streamlined Thermal Oiler with plastic reinforced reservoir that automatically supplies the proper amount of oil for solid, wick and waste packed bearings where only a small amount of oil is required. It drops oil automatically when bearing heats and stops feeding when bearing cools. Bottle Oiler style has a vibrating rod which releases oil to the bearing. Trico Fuse Mfg. Co.

48 **Vibration Control**—Korfund Co. 4-pg bulletin No. SL500 presents the Korfund SL Universal Vibro-Isolator. This booklet contains complete data on rated loads, weights and dimension in the six basic sizes.

49 **Free Repair Handbook**—Company offers free 40-pg guide for the use of Smooth-On cements, containing 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

50 **Heat Transfer Equipment Manual**—Installation photos and construction details of Downington heat exchangers are given in 28-pg bulletin. Also contains design formulas, tube sheet layout tables and other useful engineering data. Downington Iron Works.

51 **Packing Guide**—Catalog 40 is a valuable packing guide of information on packings for all services. Clearly illustrates and describes various packings of this company; suggests varied packing styles from which to choose a substitute packing. Also provides engineering data and other informative charts. The Belmont Packing & Rubber Co.

52 **Sectional Furnace Walls**—George P. Reintjes Co.'s 4-page bulletin outlines principles underlying Reintjes sectionally supported furnace walls.

53 **Underground Pipe Conduit**—Bulletin 451, entitled "Therm-O-Tile, the conduit for "Underground Pipe Lines," covers its four main advantages: (1) Keeps underground pipe insulation dry. (2) Holds grade of the piping permanently. (3) Has greater strength than is required by the American Society of Testing Materials. (4) It is competitive in initial cost. H. W. Porter & Co.

54 **Industrial Lubrication Chart**—New chart on Modern Industrial Lubrication contains helpful ideas on lubricating 139 different types of power and production equipment. Should be useful to operating and maintenance men. Adam Cook's Sons, Inc.

UNIFORM ACCURACY TO 1250°F

PRINCO

HIGH TEMPERATURE MERCURIAL THEMOMETERS

Here is the line of mercurial thermometers that maintain constant, uniform accuracy over the broad range from 30° to 1250°.

The Princo High Temperature Thermometer combines four outstanding developments in design and construction for accurate high temperature measurement:

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Princo High Temperature Thermometers offer accurate measurement at low cost, elimination of electrical connections, and simple, maintenance-free operation. Write today for complete data and prices.

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Alco Prefabricated-Pipe Service

Expert Pipe Benders for All Export or Home Needs

To handle a pipe-prefabricating job right—quality, price and delivery—is a tough job, especially for export.

Bending and heat-treating are no easy arts. But for export—there is the added trouble of boxing. It takes a great deal of experience to box prefabricated pipe involving complicated bends. ALCO does it in a way that saves ship space and gets you the lowest possible shipping charges.

Large, completely equipped ALCO shops produce prefabricated piping to close tolerances in all alloys. Its facilities include stress-relieving and annealing furnaces, big bending tables and machines, modern apparatus for X-ray inspection, its own special boxing department.

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ALCO knows every custom, rule and regulation affecting prefabricated-pipe shipments for export—meets your boat schedules—smooths the progress of your prefabricated-pipe job *all the way.*

Also available — ALCO Electric-welded Steel Pipe

In addition to prefabricated piping, ALCO makes electric-welded steel pipe from 20-inch to 120-inch diameters in lengths up to 40 feet.

American Locomotive

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A large intake pipe under a bay of the Atlantic Ocean developed a series of serious leaks which allowed an average head of 20 feet of water to pour through. Emergency action was necessary and a diver made an unsuccessful attempt to find the leaks from the water side.

Stonhard Company's technical staff was called upon. They used STONHARD STONTITE with Standard Portland Cement to plug the leaks *from the inside of the pipe.*

The torrent was stopped instantly.

THIS IS ONLY ONE JOB IN WHICH STONHARD STONTITE'S PERFORMANCE PROVED SUPERIOR . . . *What Stonhard Stontite has done for others, it can do for you.*

NO JOB TOO LARGE OR TOO SMALL FOR

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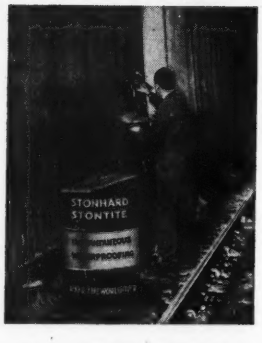
Stonhard Stontite will stop leakage, torrent or trickle, permanently against direct water pressure in dams, reservoirs, tunnels, pump wells, elevator pits, scale pits, manholes, basements, floors and walls.



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Electrical Industry Reports Record

IN THE TABLES and charts of the annual Statistical Bulletin of The Electric Light and Power Industry, published by the Edison Electric Institute following V-E Day, the measure of America's vast industrial accomplishment in supplying the Allies with arms is accurately recorded. The bulletin points out that nearly a kilowatthour of electricity was used for every dollar spent by the American people for war production. Here also are shown production trends to be expected as the war with Japan quickens and some factories change over from war goods to civilian goods.

During the war the electric power industry has reached world peaks in kilowatthours, capacity to produce electricity, customers, revenues, taxes—and all this with a comparatively small increase in new generating plans and with an actual drop in workers, rates and replacement materials. While other costs of living climbed, rates for electricity went down.

As war communiques grow shorter and revocations of controls on civilian manufacturing grow longer, the electric power industry reports that during the war years installed capacity of power houses increased 25 per cent, total power produced gained 77 per cent, the number of electric power customers went up by one and a half million, revenue from sales climbed by 43 per cent, and at the same time the average price per kilowatthour dropped by one-quarter.

All told, the electric power industry found that in 1944 it supplied twice as much electricity as it did when the European conflagration commenced in 1939, without any increase in net earnings over 1939. The actual cost to the customer for this doubled electricity output was only 43 per cent higher.

Since electricity represents about one and a half per cent of the cost of a finished manufactured product, it is hard to trace just what electricity contributed to the jeep. The war years brought an increase of more than 8 million kilowatts of generating capacity (still leaving a reserve capacity of 8 million kilowatts). Distribution of power by private industry and the government climbed beyond 230 billion kilowatthours, an increase of 62 billion.

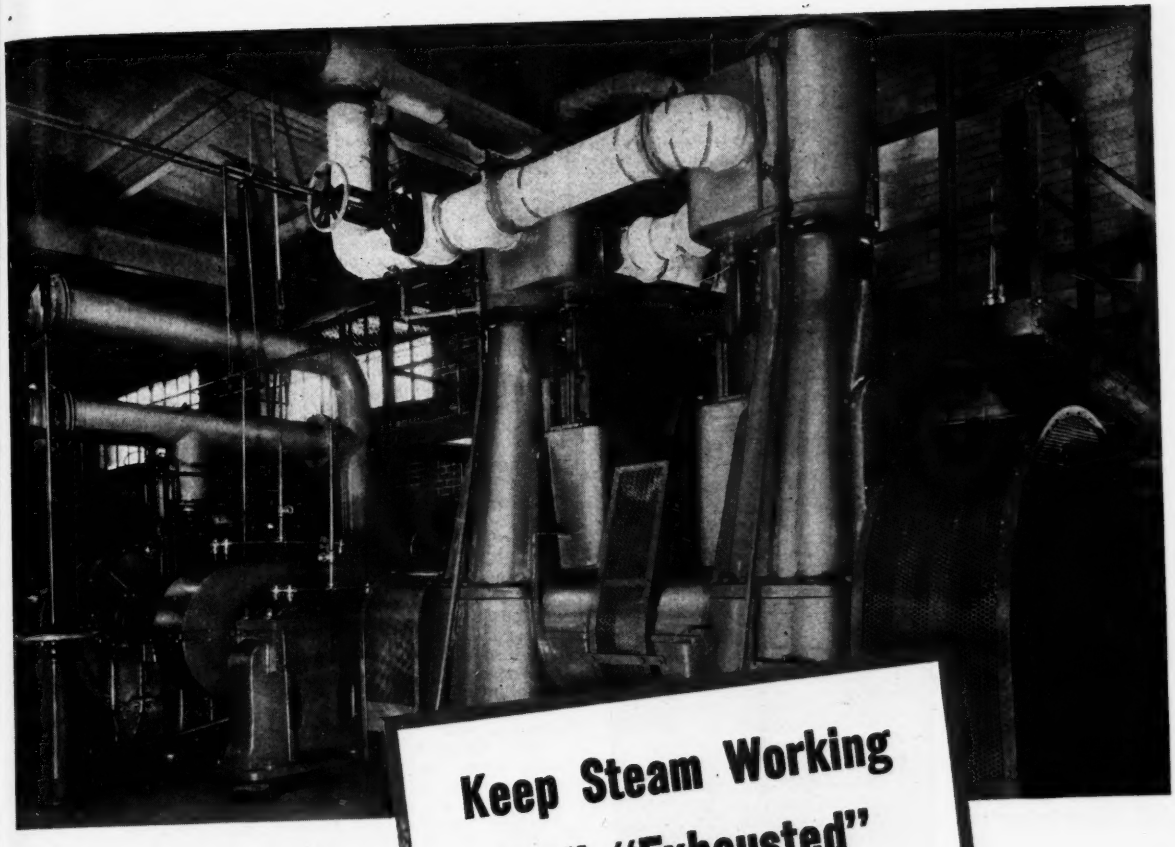
At the start of the war there was a cry that the electric light and power industry could not supply all the current needed to fight a global conflict. Yet power was provided for every war need without cutting off any power for civilian use.

Charts and tables of the statistical Bulletin provide some clues to future production. With 30 million of this country's 36 million families already living in homes wired for electricity, the promise of expansion here is relatively small and mostly rural. But trends in the home consumption of electricity have continued a steady growth through decades, surprising even the power industry on the gains in use of electrical appliances. This growth is expected to continue.

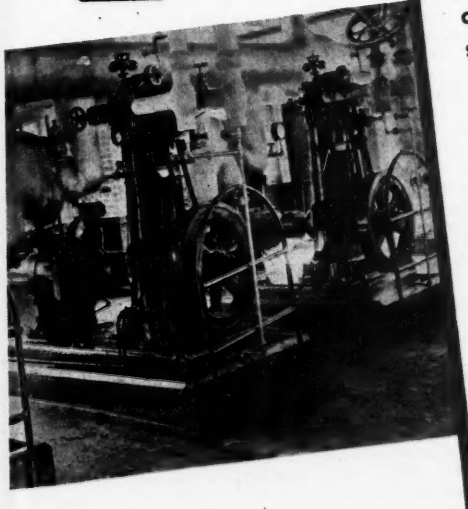
The Bulletin reported: "There was a greater use of current arising from the keener appreciation by customers of the value of the service that electrical equipment can give and the consequent restoration to active use of many thousands of hitherto idle appliances. The annual use of current by the average residential customer totaled 1,151 kwhr at the end of 1944, as compared with 1,070 the year before—an increase of 81, or 7½ per cent, over 1943."

The persistent increase in this use of residential electricity will help to offset the decline in war contracts, which, according to the Federal Reserve Board figures, show that a third of the total consumption of electricity is directly for war production, thus the end of the war in the Pacific would send current consumption down by approximately a third of the 230 billion kwhr used in 1944, to the figure of about 150 billion. There will be a slow peacetime climb as replacement of consumer and semi-durable goods commences and as new products and new uses of electricity develop.

During the five years since the outbreak of the war in Europe the revenue of the electric light and power industry going to Federal, state and local government has increased 100 per cent. During this five-year period the share of government in electric power revenue rose from $352,000,000 in 1939 to $703,000,000 in 1944, an increase of $351,000,000. Taxes now represent 24 per cent of all the money received by electric power companies for their consumers. In five years dividends and surpluses declined $30,000,000. During the same five years, wages paid by the industry climbed from $340,000,000 to $388,000,000.



TROY ENGBERG



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The energy thus converted can be utilized to drive a generator, stoker, blower, compressor or other equipment. After being used in this manner, the steam at proper pressure goes on to do its principal job of heating.

Savings in power costs—either direct or through fuel economies—quickly repay your entire investment sometimes in as little as one year.

If you use low-pressure steam in your plant for heating or processing, investigate the possibility of using Troy-Engberg Steam Engines to provide By-Product Power.

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876 RAILROAD AVENUE — Established 1870 — TROY, PENNSYLVANIA

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The men who are holding good jobs today—who are not worrying about the period ahead—are those who have kept one jump ahead of their jobs. They are the men who are equipped with a thorough-going and growing knowledge of the business they are in.

It works in the power plant field as well as in any other. Some men fit themselves to do a little more than their job calls for. They fit themselves to do a little more than the other fellow. They make a steady effort to equip themselves with the best kind of job insurance there is—KNOWLEDGE.

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POWER PLANT PRACTICE

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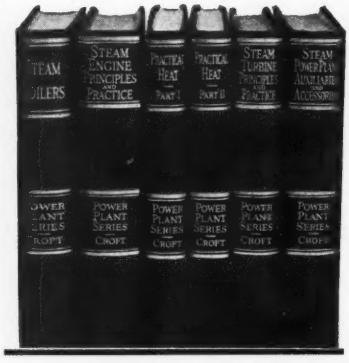

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POWER PLANT Construction News

Calif., Los Angeles—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensions and improvements in underground electrical distribution system at Naval Drydocks, Terminal Island, San Diego, to cost about $400,000. Appropriation is being arranged in budget for coming Federal fiscal year, beginning July 1.

Conn., Devon—Connecticut Light & Power Co., 36 Pearl St., Hartford, Conn., has made application for a priority rating for proposed new steam-electric generating station at Devon, to be equipped for initial capacity of about 45,000-kw. Also for extensions and improvements in power plant at Montville, with installation of new boiler units for high-pressure service and auxiliary equipment. No official estimate of cost announced. Also will make extensions in transmission lines in areas noted.

Del., Wilmington—American Viscose Corp., Delaware Trust Bldg., Wilmington, viscose rayon products, plans installation of electric power equipment in connection with expansion in mills at Marcus Hook and Lewistown, Pa.; Parkersburg, W. Va.; and Front Royal, Va., for increased production of high-tenacity rayon yarns for tire cord manufacture for Government. Gross capacity increase will approximate 46,000,000 lb. annually. Also will make extensions in power plants and facilities for distribution at different mills. Entire project will cost about $6,000,000, and is scheduled for completion by close of year.

Ind., South Bend—Studebaker Corp., Automotive Division, plans installation of electric power equipment in new two and six-story addition to automobile body works, 225 x 635 ft. Cost reported over $2,000,000, with machinery. Project will have a prority rating and work will be placed under way soon. Giffels & Vallet, Marquette Bldg., Detroit, Mich., are consulting engineers.

Iowa, Ames—State Board of Education, Des Moines, plans addition to power plant at Iowa State College, Ames, with installation of additional equipment for increased capacity. Also plans new electrical engineering building at institution. Fund of $2,297,500 has been authorized for this and other building expansion at college. A. H. Kimball, Ames, is architect.

Iowa, Council Bluffs—State Board of Education, Des Moines, plans extensions and improvements in boiler plant at Iowa School for Deaf, Council Bluffs, used for central-heating service, with installation of new boilers unit and accessories. Cost about $140,000. Appropriation in that amount has been authorized.

La., Shreveport—Brewster Co., 50 Fannin St., oil well equipment and supplies, now in production for war materials for Government, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire. Loss reported close to $400,000, with machinery. Project will have a priority rating.

Mass., Springfield—Van Norman Co., 3640 Main St., machine tools and parts, plans installation of electric power equipment in new two-story addition, about 125 x 300 ft., reported to cost over $150,000, with machinery. Project has a priority rating and work will proceed at once.

Mich., Detroit—Detroit Aluminum & Brass Corp., 3975 Christopher Ave., aluminum, brass, bronze and other nonferrous castings, bushings, etc., plans installation of electric power equipment in new one-story plant addition, 110 x 145 ft., reported to cost over $100,000, with machinery. Project will have a priority rating. Charles N. Agree, Book Tower Bldg., Detroit, is architect.

Minn., Alexandria—Board of Public Works is considering an expansion and improvement program at municipal power plant, with installation of additional equipment for increased rating. Proposed to engage engineer to make surveys and estimates of cost in near future.

Minn., Litchfield—Municipal Light and Power Department has engaged Pfeifer & Shultz, Wesley Temple Bldg., Minneapolis, Minn., consulting engineers, to make surveys and estimates of cost for proposed expansion in municipal power plant, including installation of equipment for increased capacity.

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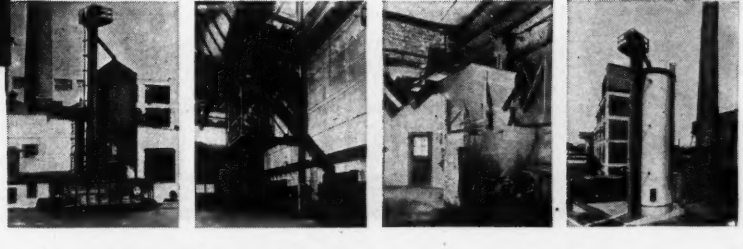

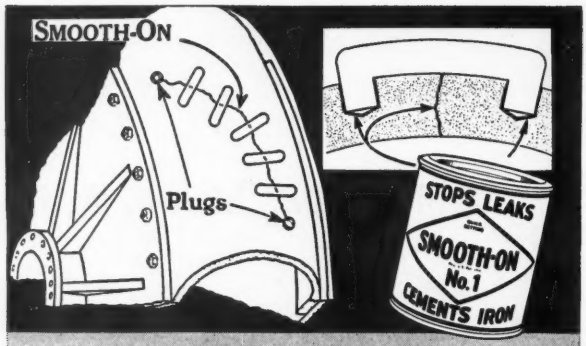

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N. J., Murray Hill—Bell Telephone Laboratories, Inc., 463 West St., New York, N. Y., telephone and radio apparatus, X-ray machines, etc., plans installation of electric power equipment in new addition to electrical and mechanical research and development laboratories at Murray Hill, consisting of several new buildings, reported to cost over $1,000,000. This will be a postwar project.

N. Y., New York—National Dairy Products Corp., 230 Park Ave., New York, plans group of large plants as a postwar development, including milk processing and bottling plants at Philadelphia, Pa., and Kansas City, Mo., respectively; ice cream factories and butter plants at Omaha, Neb., and Milwaukee, Wis., each to comprise several units. Electric power equipment will be installed. Boiler houses and power substations will be built. Entire project is reported to cost over $6,000,000.

Ohio, Akron—Board of Directors, University of Akron, Buchtel St., H. E. Simmons, president, has tentative plans for new boiler house for central-heating service at institution, estimated to cost close to $175,000, with boiler units, pumps and auxiliary equipment.

Ohio, Cincinnati—Andrew Jergens Co., 2535 Spring Grove Ave., toilet soaps, perfumery, cosmetics, etc., plans large plant on Reading Rd., Bond Hill district, where tract of about 65 acres of land has been acquired, to be carried out as postwar development. It will comprise a main one and multi-story building and auxiliary structures, with machinery and electric power equipment for large capacity. A power plant is planned. Entire project reported to cost over $1,000,000. A. M. Kinney, Inc., Enquirer Bldg., Cincinnati, is consulting engineer.

Ohio, Montpelier—Montpelier Municipal Utilities, Bryant St., has made application for a priority rating for extensions in municipal power plant, including installation of new three-drum watertube boiler and auxiliary equipment. Bids will be asked as soon as priority is secured. No estimate of cost announced.

Ohio, Steubenville—Sinclair Refining Co., 235 Weaver St., Toledo, Ohio, plans new bulk marine oil terminal on Ohio River at Steubenville, where tract of land is being secured. It will comprise several warehouse buildings, with boiler plant, pumping station, steel pressure tanks and other operating facilities. Project will be carried out in conjunction with proposed construction of new 8-in. pressure gasoline pipe line from present bulk terminal at Toledo to Columbus, Ohio, and Steubenville. Entire development is reported to cost about $4,000,000. This will be a postwar project. Main offices are at 630 Fifth Ave., New York, N. Y.

S. D., Miller—Light and Power Department, Miller, plans expansion and improvements in municipal power plant, including installation of new Diesel engine-generating unit, about 500-hp. rating, and auxiliary equipment. Surveys and estimates of cost are being made by Charles P. Trimmer, Mitchell, S. D., consulting engineer.

Tenn., Memphis—Nat Buring, 313 Wagner Pl., Memphis, meat packer, plans boiler house in connection with new meat-processing and packing plant on site near South Memphis Stockyards, West Trigg Ave., recently acquired. Plant will comprise several buildings, with machinery and electric power equipment for large output. Cost reported close to $225,000. It is understood that application will be made for a priority rating. Nat Buring in charge.

Texas, Austin—City Council, City Hall, Walter E. Seaholm, acting city manager, has tentative plans under advisement for new municipal hydroelectric generating plant on Colorado River, with low-water dam, as a postwar development. Output of plant will be used for pumping service for water system. Cost estimated about $750,000, with hydraulic turbine and auxiliary equipment.

Texas, Corpus Christi—Bureau of Aeronautics, Navy Department, Washington, D. C., plans extensions in power stations at Cabaniss Field, Cuddihy Field, Rodd Field and Waldren Field, all in Corpus Christi area, including installation of new engine-generator units and auxiliary equipment, each to cost about $38,000 for three first noted stations, and $42,000 at Waldren plant. Appropriations are being arranged in budget for coming Federal fiscal year, beginning July 1. Bureau of Yards and Docks, Navy Department, Washington, will be in charge.

Wis., Columbus—Municipal Water and Light Department, City Hall, has plans under way for extensions and improvements in municipal power station, with installation of additional equipment for increased capacity. Not announced if program will be carried out at present time or deferred as a postwar project. Buell & Winter Engineering Co., Sioux City, Iowa, is consulting engineer.

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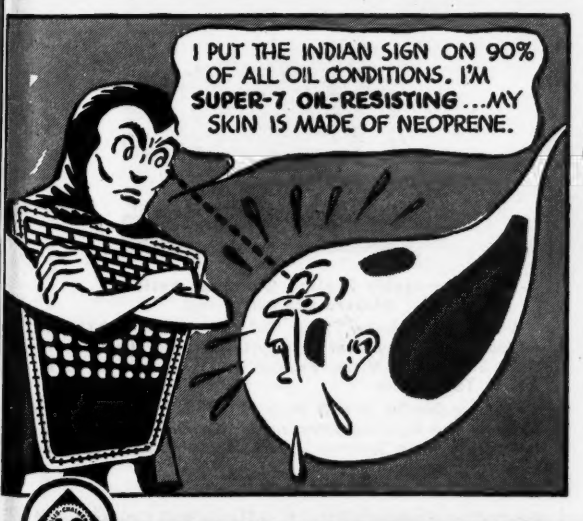

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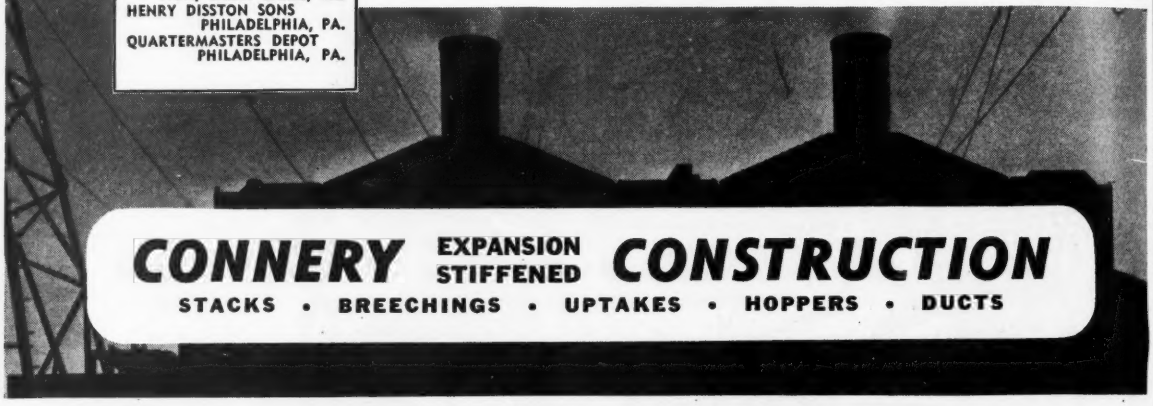

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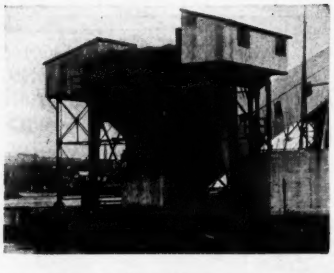

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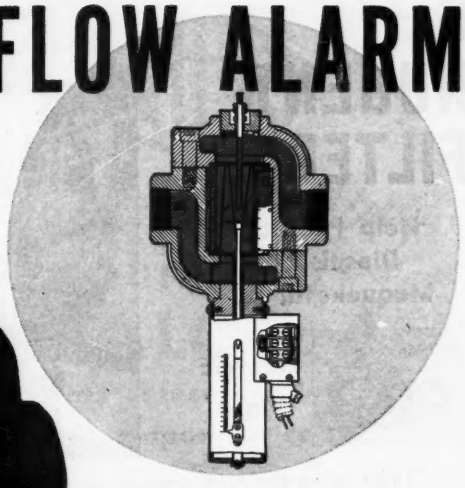

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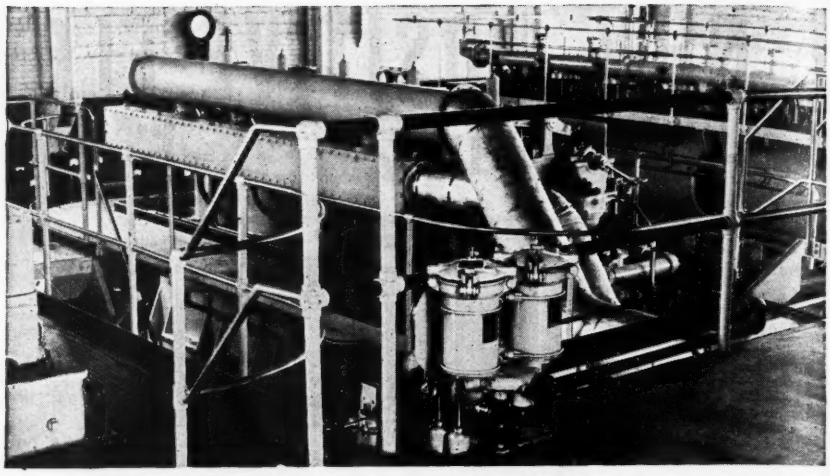

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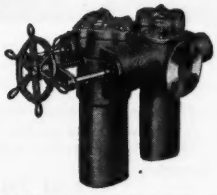

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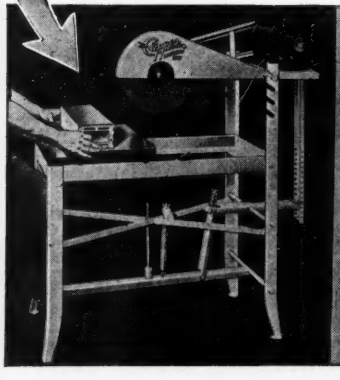

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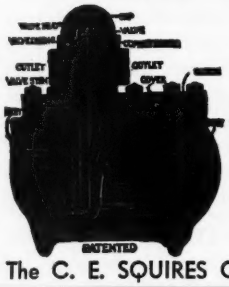

saves your fuel bill as it operates without loss of steam.

May we send Catalog E-9 giving complete information.

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We'd be in a peck of trouble if we didn't because we guarantee each Hercules Float to stand up under as high as 350 lbs. working pressure and 500° of temperature for one year. That's why we make them of seamless copper, by our special process, uniform in thickness and high in mechanical strength. We are safe in guaranteeing them. You are safe in specifying them.

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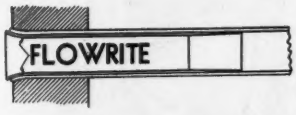
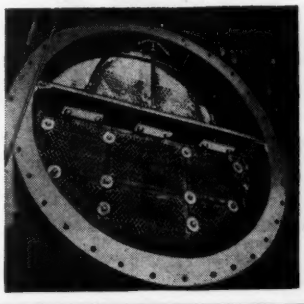
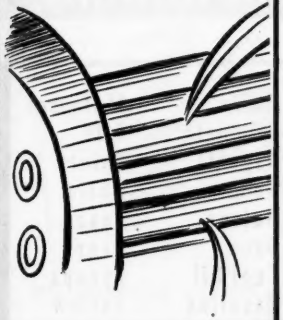
CONDENSER and HEAT EXCHANGER SERVICE TROUBLES and REMEDIES

TROUBLE	REMEDY (tried and proven by years of service)
ERODED TUBE ENDS	**FLOWRITES** — Short, belled-end inserts for condenser tube inlet ends. Protect old and new tubes from erosion. Easy to install. Inexpensive to renew. Proven successful over 20 years.  **AIR and EROSION ELIMINATOR** — A special frame containing perforated plates (deaeration screens) of special metal, built into the water box facing the tube sheet. Stops electrolysis and dezincification. Gases in circulating water passing through plates are liberated and discharged through a manifold. Liberated gases attack plates instead of tubes and sheets, and plates are easily replaceable. Tube life increased at least three times normal. Proven in service. 
DEZINCIFICATION	**AIR and EROSION ELIMINATOR**—(Described above)
LEAKING TUBES 	**WIZARD INJECTOR**— Stops condenser leaks almost instantly, without a shutdown. Injects an inexpensive dry sealing compound into circulating water. Entirely harmless. Does not reduce efficiency of unit. Simple, durable construction. No moving parts. Provides inexpensive insurance against untimely condenser shutdown. **FIBRE PLUGS**—Conseco non-porous fibre plugs will not damage tube sheet. Secured with a light tap. Swell when in contact with water. Easily removed. Inexpensive.
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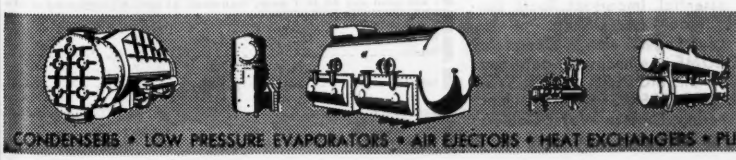

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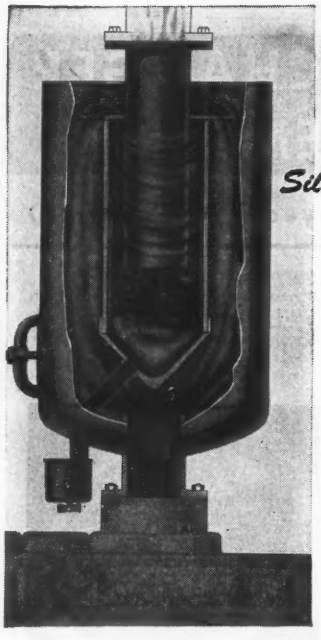

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RE-SOLICITATION is the keynote for a victorious "mop up" in the Mighty 7th War Loan. Bond rallies plus continuous competition between departments help to keep Bond subscriptions on a quota-topping climb. Strategic poster displays . . . showings of "Mr. & Mrs. America," the Treasury film . . . distribution of the War Finance Booklet, "How To Get There," and the handy Bond-holding envelopes play an important part. But, above all else, arrange to have every employee asked *once more*—and personally urged *once more*—to meet his personal quota in the Mighty 7th!

The Payroll Savings Plan is the mainstay of every War Loan—meeting your plant quota is vital to the success of the 7th! Remember we have to make two drives in 1945 do the work of three last year. Put on an intensive "mop up" final to help mop up the Japs, cut the tentacles of inflation—and lay the foundation of security.

The Treasury Department acknowledges with appreciation the publication of this message by

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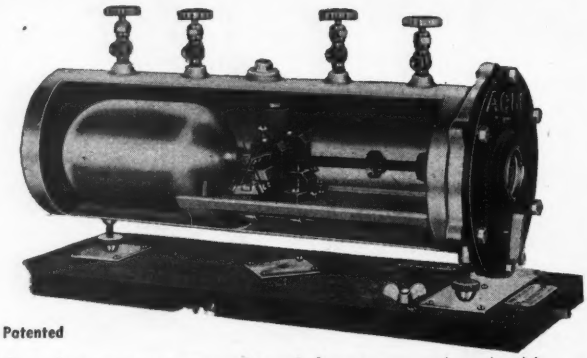
★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★

MEASURE Your GAS the AC-ME WAY



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Complete apparatus consists of these accessories: Ac-Me Air Dryer; Ac-Me Pressure Vacuum Pump; Ac-Me Tripod; Aneroid Barometer; R.S. Manometer; set of hose; base and carrying case.

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Without obligating us in any way, ☐ Please send Bulletin 381.
☐ Send representative. ☐ Enclosed is a sketch, with principal data of a prospective underground pipe job, on which we shall be glad to have your ☐ comments, ☐ quotations.

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It makes a crew job a one-man job!

It's tough keeping down maintenance costs these days — and every unnecessary job eliminated means a better record for my department. The Dexter Valve Reseating Machine has eliminated the expense of a crew that formerly had to spend hours repairing or replacing leaky valves in the plant. Now — one man reseats the valve, skillfully, effectively, *right on the line*, in a few minutes.

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Our engineers are Dexter boosters, naturally, Dexters stop those big valve-leak losses in air, steam and water — and the reseated valves actually perform better than new ones.

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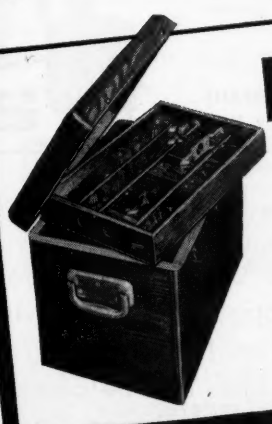

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for information on the Dexter Reseating Outfit to keep your valves in shape. Give make, type, size and material — whether steam, air or water. No obligation.

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—WON'T EVAPORATE OR DISTILL OVER

"MAGIC" Boiler Preservative has the big advantage of being non-volatile. It will not evaporate or distill over with the steam.

The steam from boilers using "MAGIC" is pure and free from any chemicals or injurious gases. It can be used directly in processing industries without injury to products.

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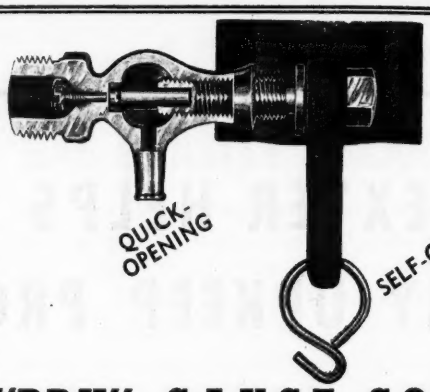

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Simply shovel INSTANT-USE into the hole or rut — tamp — and your floor is ready for traffic without the usual wait for setting. Keep a drum on hand for emergencies. Immediate shipment.

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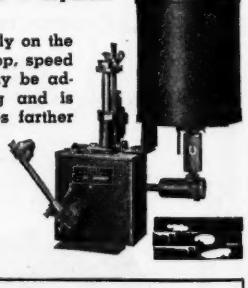
Manzel Feeders are installed directly on the boiler feed water pump and start, stop, speed up and slow down with it. Feed may be adjusted while the pump is operating and is very accurate. Boiler compound goes farther and does a better job when injected by a Manzel Feeder.



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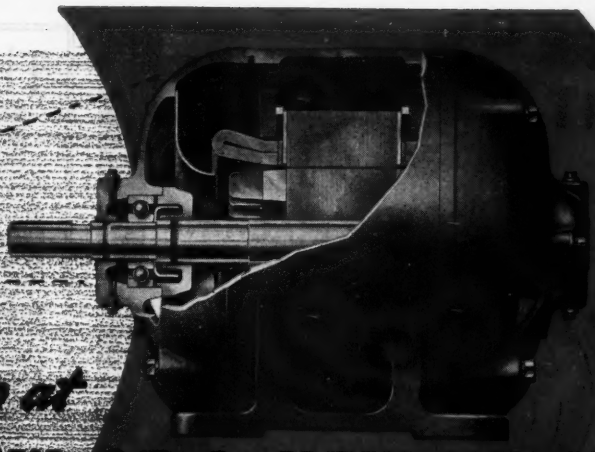
A CUTAWAY VIEW OF A NEW TREND

in motor design



Two decades ago the purchaser of squirrel-cage motors had but one choice—the open motor. If operating conditions proved too severe, the only answer was to be found in frequent replacements.

Then came a period of new development in mechanical design, which resulted in the birth of dripproof, splashproof, totally-enclosed, fan-cooled, and a host of other new types, each designed for operation under certain adverse conditions.

But today there is a new trend—represented by Crocker-Wheeler Protected-Type Motors. These motors, besides having the surplus capacity of open designs, provide protection against many of the most common hazards encountered in operation. They may be used for many services for which enclosed and partially-enclosed motors have been specified in the past, *and yet, Protected-Type Motors cost no more than open motors.*

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Because Protected-Type Motors are drippproof, falling water, oil, or other liquids cannot enter the windings. All ventilating openings are shielded.

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Protected-Type Motors are ideal for machine tool and similar applications where metal chips and other foreign matter might injure the windings of less well-protected motors.

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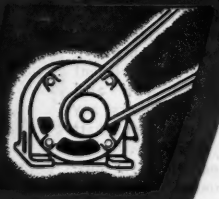
Rated 40C rise, full-load continuous duty, with a 15 per cent service factor, these motors are suitable for all general-purpose applications. Mounting dimensions conform to N. E. M. A. standards.



FOR COMPLETE DETAILS, send for your FREE copy of this NEW four-page bulletin. Shows how these motors are protected; why they will give long trouble-free service. Write today — no obligation.

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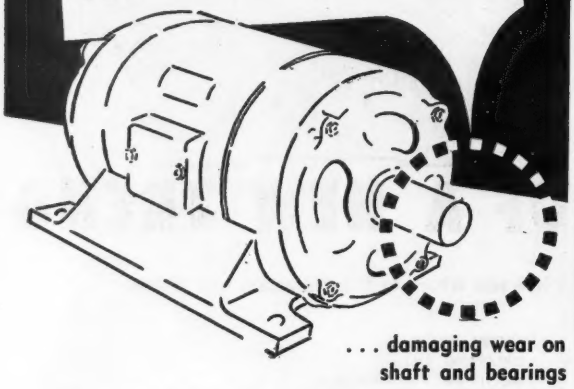
SQUIRREL CAGE MOTORS WOUND ROTOR MOTORS DIRECT CURRENT MOTORS GENERATORS FLEXIBLE COUPLINGS

IT *CAN* HAPPEN *here* TO THE BEST MACHINE

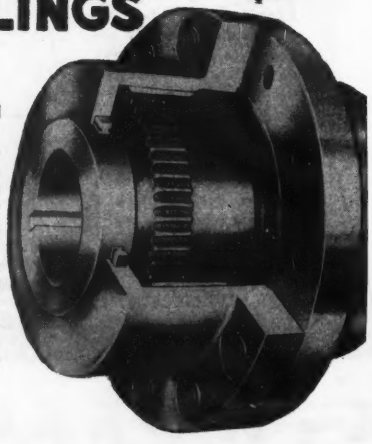


. . . damaging wear on shaft and bearings

"Penny wise and pound foolish" is the old adage that best describes the practice of using any old coupling with a good and costly machine. By preventing wear to the shaft and bearings

YOU ACTUALLY **SAVE**
WHEN YOU SPECIFY AND USE

WALDRON *Gear Type* COUPLINGS



Forged steel hubs and sleeves (no welding) avoid need for frequent repair or replacement; complete freedom of movement between hub and sleeve prevents any added stress on shaft and bearings while compensating for misalignment. Other design refinements described in our Catalog No. 56.

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COUPLINGS

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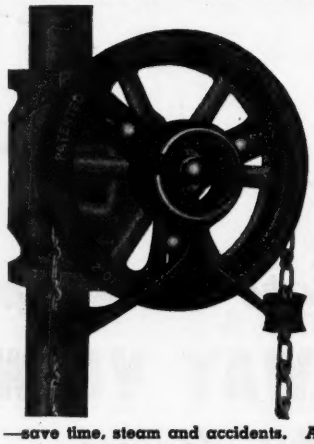

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Babbitt Rims give you instant and positive control of overhead valves from the floor —save time, steam and accidents. Adjustable to any valve, easily attached and low in cost. Don't delay. Get your Babbitt Rims now! Complete information on request.

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Babbitt
—Adjustable—
SPROCKET RIM
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STEAM CONDENSERS
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STEAM EJECTOR TYPE VACUUM PUMPS
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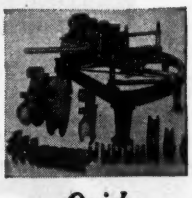
12,000 *customers — and more — can testify to the indispensability of "American" machines. Here are a few users:* Bureau of Ships, Wash., D. C.; Henry J. Kaiser Co., Calif.; Pacific Bridge Co.; Bethlehem-Hingham Shipyards; Hercules Powder Co.; Stone & Webster; E. I. Du Pont de Nemours & Co.; Crane Co.



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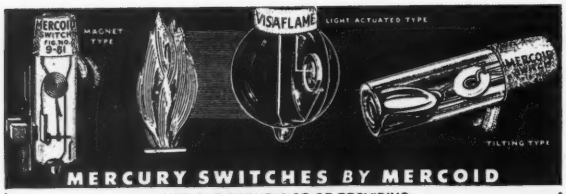

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OF "MAKES" AND "BREAKS" IN THE ELECTRICAL CIRCUIT

THEY ASSURE FULL PROTECTION AGAINST SWITCH TROUBLES

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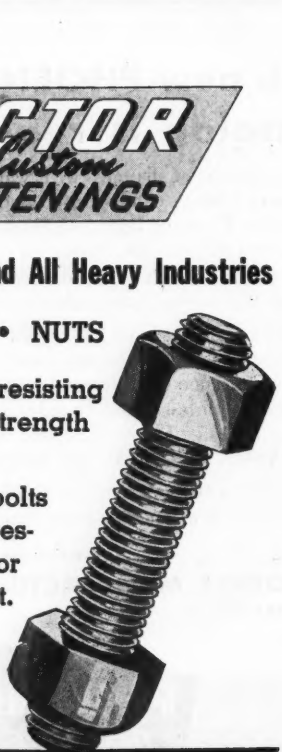

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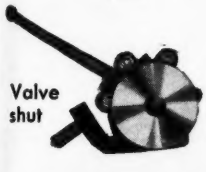

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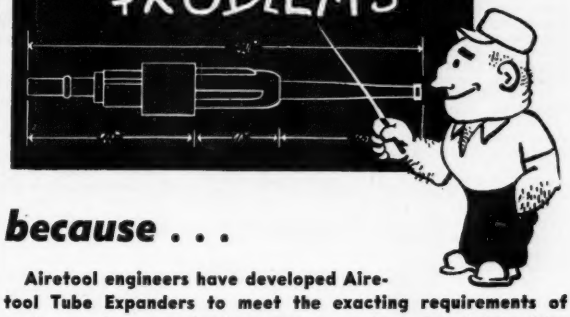

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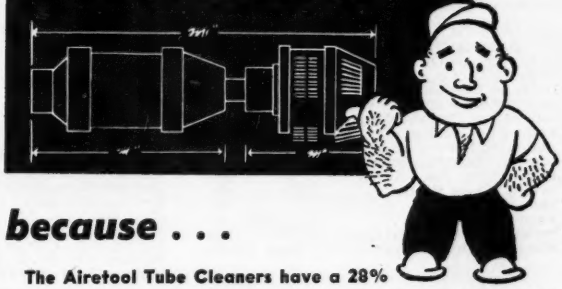

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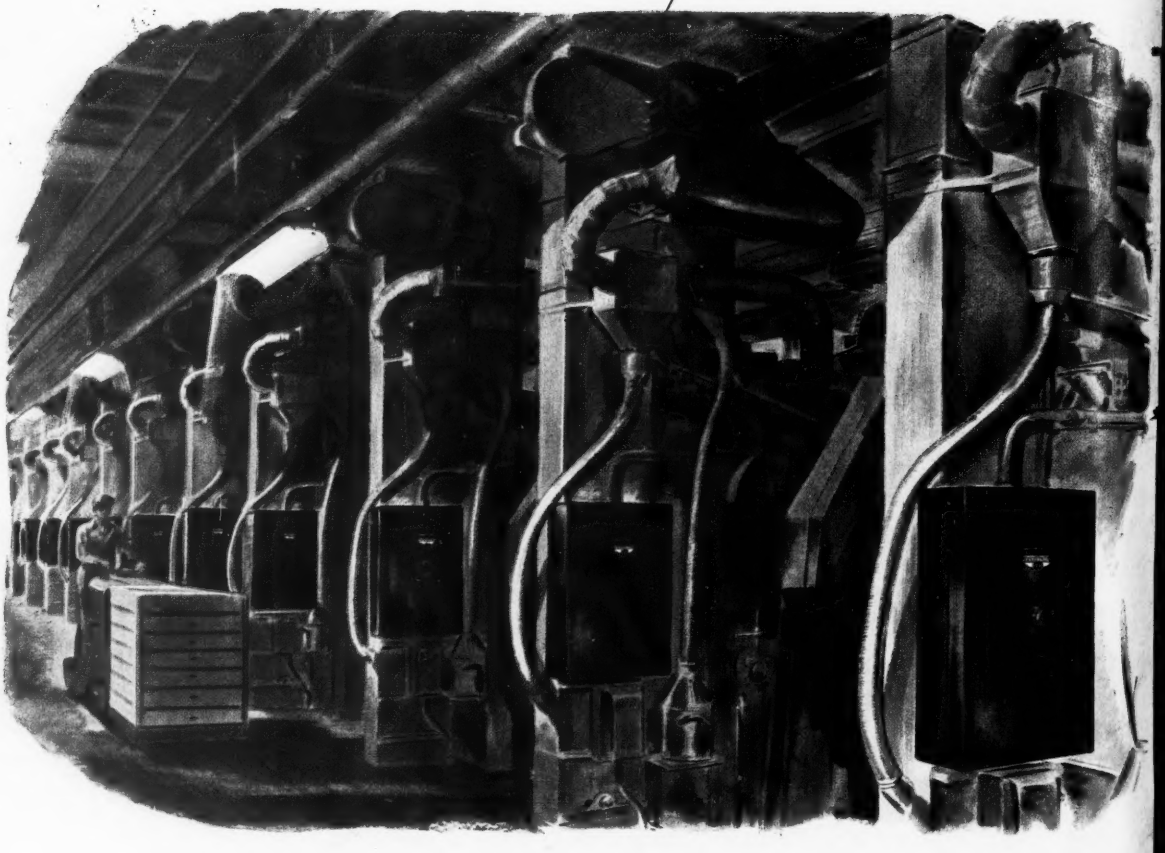

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